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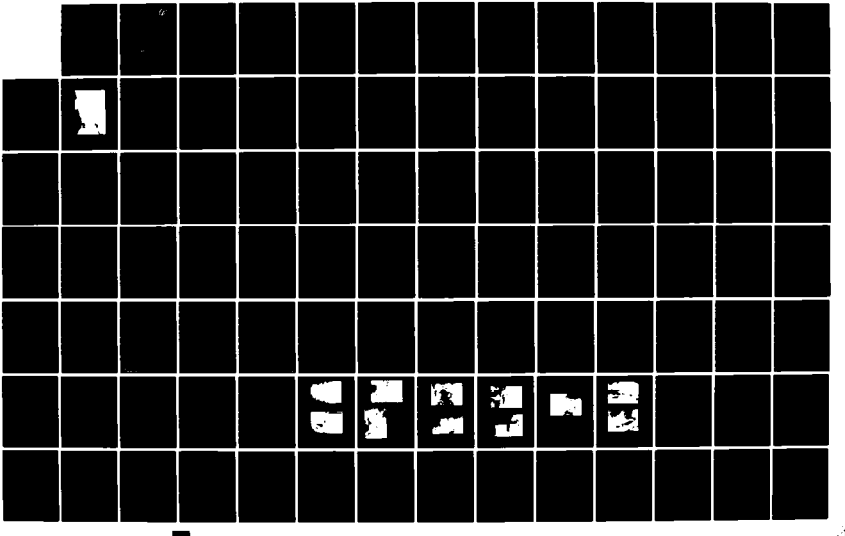

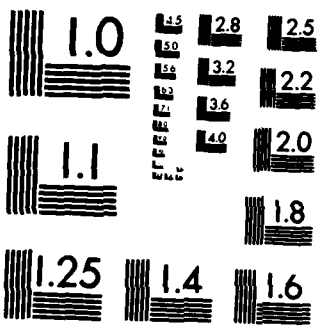

MASSACHUSETTS COASTAL BASIN
WAREHAM, MASSACHUSETTS

TIHONET POND NO. 2 DAM
MA 00030

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

JULY 1981

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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4. TITLE (and Subtitle) Tihonet Pond No.2 Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE July 1981 13. NUMBER OF PAGES 70
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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,
Massachusetts Coastal Basin
Wareham, Massachusetts

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Tihonet Pond No.2 Dam consists of an earth embankment with a vertical stone masonry wall over a portion of the downstream face. The embankment has a minimum top width of approximately 30 feet, a maximum height of 15 feet. Based on visual inspection and a review of all available data, the dam is considered to be in poor condition. The dam is classified as "Intermediate" in size, with a "High" hazard potential. A test flood equal to the PMF was selected.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

NEDED

AUG 19 1981

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Tihonet Pond No. 2 Dam (MA-00030) Phase I Inspection Report, prepared under the National Program for Inspection of Non-Federal Dams. This report is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. I approve the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is vitally important.

Copies of this report have been forwarded to the Department of Environmental Quality Engineering, and to the owner, A.D. Makepeace Company, Wareham, MA 02571. Copies will be available to the public in thirty days.

I wish to thank you and the Department of Environmental Quality Engineering for your cooperation in this program.

Sincerely,

William E. Hodgson, Jr.

Incl
as stated

WILLIAM E. HODGSON, JR.
Colonel, Corps of Engineers
Acting Commander and Acting Division Engineer

TIHONET POND NO. 2 DAM

MA 00030

MASSACHUSETTS COASTAL BASIN

WAREHAM, MASSACHUSETTS

PHASE 1 INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE 1 INSPECTION REPORT

IDENTIFICATION NO.:		MA 00030
NAME OF DAM	:	TIHONET POND NO.2 DAM
TOWN	:	WAREHAM
COUNTY AND STATE	:	PLYMOUTH, MASSACHUSETTS
STREAM	:	WANKINCO RIVER
DATE OF INSPECTION:		DECEMBER 9, 1980

BRIEF ASSESSMENT

The Tihonet Pond No. 2 Dam consists of an earth embankment with a vertical stone masonry wall over a portion of the downsteam face. The embankment has a minimum top width of approximately 30 feet, a maximum height of 15 feet, and upstream and downstream slopes that vary from vertical at a downstream cut-stone masonry wall to approximately 2 H to 1 V. The overall length of the dam is approximately 660 ft. Included in this length are two spillway structures located at the left and right ends of the dam. These structures consist of stoplogs in concrete slots emptying into conduits that pass through the dam.

The dam impounds Tihonet Pond, which is used for irrigation

and recreational purposes. Water from this pond is used in the irrigation of cranberry bogs downstream. The maximum storage capacity of the dam is about 1250 acre-feet.

Based on visual inspection and a review of all available pertinent data, the dam is considered to be in poor condition. Features that could effect the structural integrity of the dam include wet areas at the downstream toe of the dam, erosion and slumping of dam slopes, extensive tree growth on the dam slopes, movement of the downstream vertical masonry wall.

Based on the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, the dam is classified as "Intermediate" in size, with a "High" hazard potential. A Test Flood equal to the Probable Maximum Flood (PMF) was selected in accordance with the Corps of Engineers' Guidelines. The calculated test flood outflow from the pond was about 5500 cfs. The test flood would overtop this dam by about 0.5 ft., it would also overtop a second dam located on this pond, Tihonet Pond No. 1 Dam, by about 2.5 ft. The crest of this second dam is approximately elevation 40 NGVD. The spillway for this dam would carry about 10% of the Test Flood.

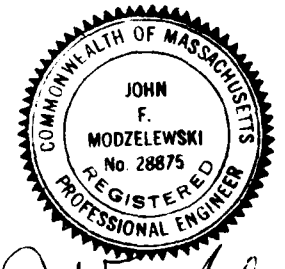
Recommendations include that the owner engage the services of a qualified registered engineer to specify and oversee the removal of trees and root systems on the embankment, investigate the cause of wet areas at the toe of the dam embankment, design and oversee construction of erosion protection for the upstream face and crest of the dam, investigate the stability of the bulged area at the downstream masonry wall.

A detailed hydrologic-hydraulic investigation to assess further the potential of overtopping the dam and the need for and the means to increase project discharge capacity should be performed.

Technical inspections by a qualified, registered engineer should be performed every year. A formal downstream warning system should be put into effect. A formal written maintenance program should be prepared and implemented.

The owner should implement the recommendations and remedial measures as described herein and in greater detail in Section 7 of this Report within 1 year after receipt of this Phase 1 Inspection Report.

ASEC CORPORATION



John F. Modzelewski P.E.
Project Engineer/
Director of Engineering Services

This Phase I Inspection Report on Tihonet Pond No.2 Dam (MA-00030) has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

JOSEPH W. FINEGAN, JR., CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase 1 Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase 1 Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase 1 investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect

to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase 1 inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase 1 Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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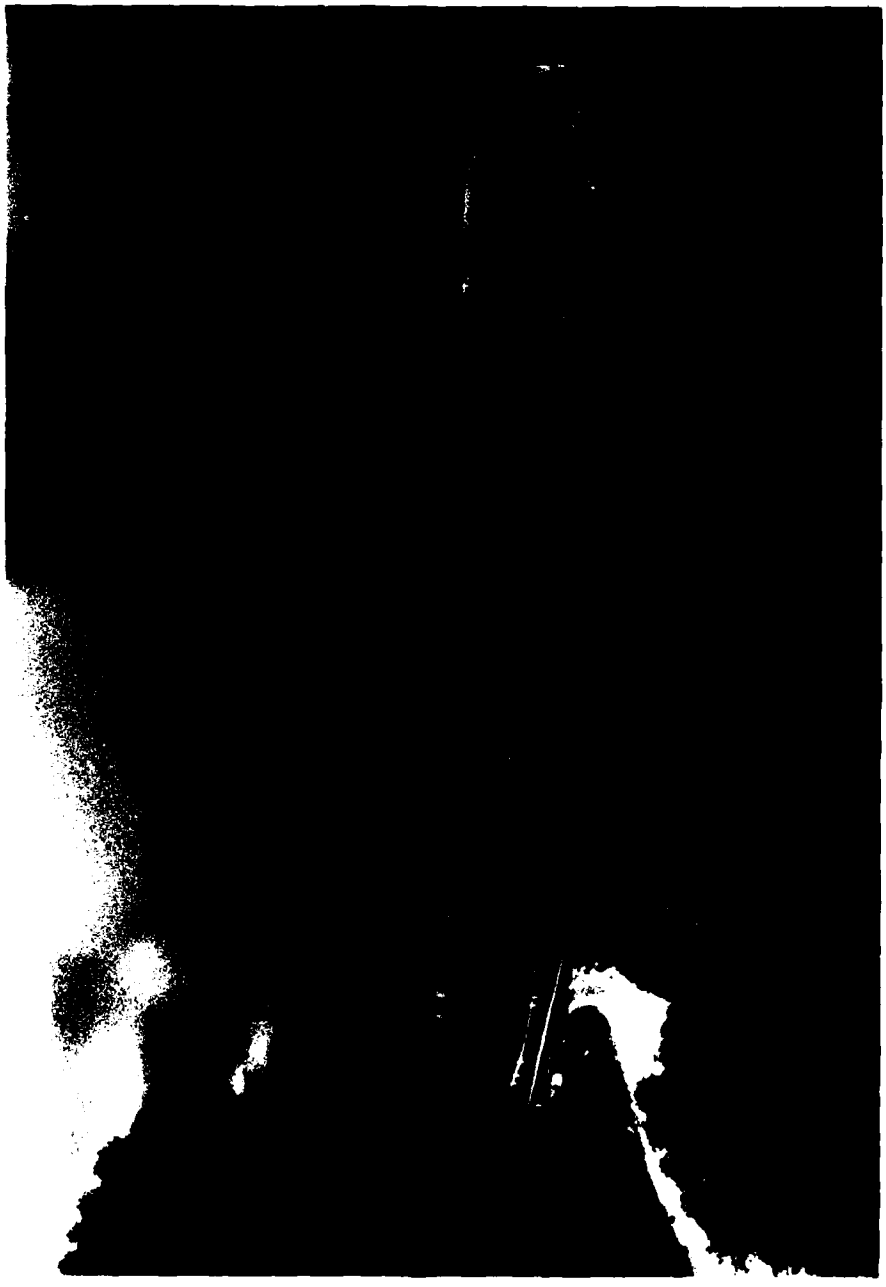
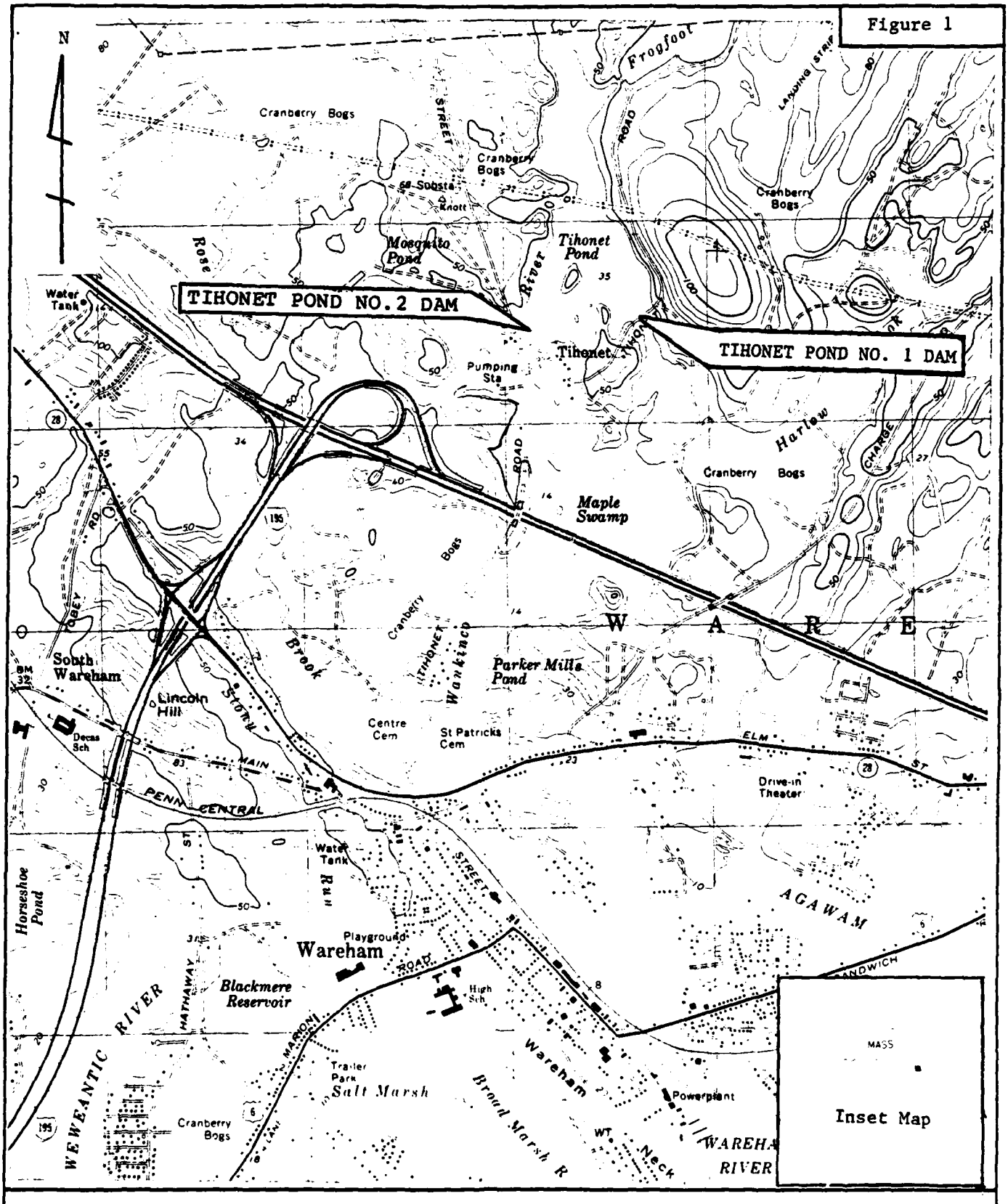


OVERVIEW PHOTO

U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM , MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	TIHONET POND NO.2 DAM TR. TO WANKINCO RIVER WAREHAM, MASS. MA 00030 DECEMBER 10, 1980
ASEC CORP. CONSULTING ENGINEERS BOSTON , MASSACHUSETTS		

Figure 1



LOCATION PLAN

TIHONET POND NO. 2 DAM
WAREHAM, MASSACHUSETTS

SCALE: 1 : 25 000

ASEC CORPORATION

WAREHAM QUADRANGLE 1972

NATIONAL DAM INSPECTION PROGRAM

PHASE 1 INSPECTION REPORT

PROJECT INFORMATION

SECTION 1

1.1 GENERAL

a. AUTHORITY

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. ASEC Corporation has been retained by the New England Division to inspect and report on selected dams in the state of Massachusetts. Authorization and notice to proceed were issued to ASEC Corporation under a letter of December 8, 1980, from William E. Hodgson, Colonel, Corps of Engineers. Contract No. DACW33-81-C-0023 has been assigned by the Corps of Engineers for this work.

b. PURPOSE OF INSPECTION

The purposes of the program are to:

I. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interests.

II. Encourage and prepare the States to quickly initiate effective dam inspection programs for non-federal dams.

III. To update, verify and complete the National Inventory of Dams.

1.2 DESCRIPTION OF PROJECT

a. LOCATION

The dam is located on the Wankinco River between Farm to Market Road and Tihonet Road in Wareham, Massachusetts about 2 miles upstream from its confluence with the Agawam River. The dam is shown on the Wareham Quadrangle Map having coordinates latitude 41°-47.3' and longitude 70°-43.2' (See Figure 1). The dam impounds Tihonet Pond. A second dam located approximately 1800 feet northeast of this dam serves to impound the water of Tihonet Pond also. This dam is referred to as Dam # 14 on Plymouth County Inspection Reports and also as Tihonet Pond No. 1 Dam.

b. DESCRIPTION OF DAM AND APPURTENANT STRUCTURES

The dam consists of an earth embankment with a vertical stone masonry wall over a portion of the downsteam face. The embankment has a minimum top width of approximately 30 feet, a maximum height of 15 feet, and upstream and downstream slopes that vary from vertical at a downstream cut stone masonry wall to approximately 2 H to 1 V. The overall length of the dam is approximately 660 feet including two spillways: a concrete sluiceway controlled by stoplogs with a total weir length of 8.8 ft. emptying into a low level twin 4.2 ft. x 3.6 ft. concrete box

culvert located near the right side of the dam and a second concrete sluiceway controlled by stoplogs with a total weir length of 8.4 ft. emptying into a 5 ft. diameter pipe outlet near the left side of the dam. In addition to these structures a plugged outlet is located approximately 100 ft. to the right of the 5 ft. pipe outlet. A feature which appears to have been an old channel is located about 100 ft. to the left of the pipe outlet. Further data on the dam is contained in Section 1.3. A sketch plan of the dam is located in Appendix B page B-1.

Approximately 1800 ft. northeast of this dam a second dam is located. This dam is referred to as Dam # 14 on Plymouth County Inspection Reports and is also listed as "Tihonet Pond No. 1 Dam - I.D. # MA 00029" on the National Inventory of Dams. The dam is an earthen embankment about 15 ft. high, about 80 ft. wide, and has a crest length of about 400 ft. The crest of the dam is at elevation 40 $\pm$ NGVD. Discharge from this site is through 3 - 30 inch culverts and 2 - 24 inch culverts. Outflow from the 3 - 30 inch culverts is controlled by a stoplog structure at the downstream end of the culverts. The stoplogs can be controlled to deliver water to a fishladder or directly to a channel below the culverts. The 2 - 24 inch culverts are controlled by stoplogs in concrete slots at the upstream end of the pipes. These pipes outlet to an earth channel downstream of the site. This dam is shown in Photo # 10 and Photo # 11 of Appendix C.

c. SIZE CLASSIFICATION - "Intermediate"

According to the Corps of Engineers' Recommended Guidelines

for Safety Inspection of Dams, a dam is classified as "Intermediate" in size if the height is between 40 and 100 feet, or the dam impounds between 1000 and 50,000 acre-feet. The dam has a maximum height of 15 ft. and a maximum storage capacity of about 1250 acre-feet. Therefore the dam is classified as intermediate in size based on storage capacity.

d. HAZARD CLASSIFICATION - "High"

Based on the Corps of Engineers' Recommended Guidelines for the Safety Inspection of Dams, the Hazard Classification for the dam is "High". The dam is classified as a "High" Hazard Potential structure because the assumed failure of the dam may result in the loss of more than a few lives and excessive economic losses. Post failure flooding will range 5 - 13 ft. higher than pre-failure flooding, and seriously damage about 8 buildings including 3 mill buildings adjacent to the dam and 2 roads. See Appendix D for assumed failure analysis.

e. OWNERSHIP

Former Owner : Tremont Nail Company

Present Owner : A.D. Makepeace Company
Box 151 - 266 Main Street
Wareham, MA 02571
(617) 295-1000

f. OPERATOR Mr. Christopher Makepeace
A.D. Makepeace Company
Box 151 - 266 Main Street
Wareham, MA 02571
(617) 295-1000

g. PURPOSE OF DAM

The dam impounds Tihonet Pond which is a storage reservoir

used principally for irrigating cranberry bogs which are also owned and operated by the A.D. Makepeace Co. In addition a rod and gun club has leased fishing rights from the owner, consequently the reservoir is used for fishing and other water related activities.

h. DESIGN AND CONSTRUCTION HISTORY

Design plans for the original dam are not known to exist. The original construction date of the dam is unknown. The dam was probably built in the eighteenth century and certainly no later than the early nineteenth century since the original purpose was to provide water power to an iron rolling mill which existed up to the end of the nineteenth century. From 1880 to 1939 the control and finally ownership of the reservoir and dam was transferred to the present owner.

According to an inspection report by the Massachusetts Department of Public Works dated 8/2/73 the left side concrete sluiceway was replaced in approximately 1954-55. In approximately 1979 some repair work was done to the downstream masonry wall. This work apparently consisted of mortaring portions of the wall. "As-built" sketches made by the Plymouth County Engineering Dept. in 1936 and updated to 1967 depict what is probably the original design concept for the dam. The sketches are part of the Plymouth County Commissioners Dam Inspection records and are included in Appendix B.

i. NORMAL OPERATIONAL PROCEDURES

The outlet stoplogs are adjusted by the owner's personnel to

control the flow of water into the bogs downstream of the dam. Occasionally the water level is lowered by removal of stoplogs to control trash fish or for maintenance/repair to the structures.

1.3 PERTINENT DATA

a. DRAINAGE AREA

The drainage area above the dam is 8.1 square miles. The watershed is characterized by irregular topography: cranberry bogs, small ponds and depressions, and several small streams. Elevations in the watershed range from El. 35 ± to El. 120 ± NGVD.

b. DISCHARGE AT DAMSITE

The discharge at the dam is controlled by two spillways. The left spillway is a concrete sluiceway controlled by stoplogs with a width of 12 ft. and a height of 11.2 ft. This sluiceway empties into a 5 foot diameter cast iron pipe. The right spillway is a concrete sluiceway controlled by stoplogs with a width of 12 ft. and a height of approximately 12.5 ft. This sluiceway empties into twin box culverts approximately 4.2 ft. wide by 3.6 ft. high.

NGVD = National Geodetic Vertical Datum

1.	Outlet Works (conduit) Size:	None
2.	Maximum Known Flood at Damsite:	Unknown
3.	Ungated Spillway Capacity	
3a.	Right spillway: (without Stoplogs) at Top of Dam	500 cfs
	Elevation:	42.0 ft. NGVD

	Right spillway: (with Stoplogs)*	
	at Top of Dam	250 cfs
	Elevation:	42.0 ft. NGVD
3b.	Left spillway: (without Stoplogs)	
	at Top of Dam:	250 cfs
	Elevation:	42.0 ft. NGVD
	Left spillway: (with Stoplogs)*	
	at Top of Dam:	250 cfs
	Elevation:	42.0 ft. NGVD
4.	Ungated Spillway Capacity	
4a.	Right spillway: (without Stoplogs)	
	at Test Flood Elevation	550 cfs
	Elevation:	42.5 ft. NGVD
	Right spillway: (with Stoplogs)*	
	at Test Flood Elevation	250 cfs
	Elevation:	42.5 ft. NGVD
4b.	Left spillway: (without Stoplogs)	
	at Test Flood Elevation:	250 cfs
	Elevation:	42.5 ft. NGVD
	Left spillway: (with Stoplogs)*	
	at Test Flood Elevation:	250 cfs
	Elevation:	42.5 ft. NGVD
5.	Gated Spillway Capacity	Not applicable
	at Normal Pool Elevation	
	Elevation:	
6.	Gated Spillway Capacity	Not applicable
	at Test Flood Elevation	
	Elevation:	
7.	Total Spillway Capacity*	
	at Test Flood Elevation	500 cfs
	Elevation:	42.5 ft. NGVD
8.	Total Project Discharge*	
	at top of Dam:	3900 cfs
	Elevation:	42.0 ft.
9.	Total Project Discharge*	
	at Test Flood Elevation:	5500 cfs
	Elevation:	42.5 ft.

* with Stoplogs at El. 35.9 $\pm$ NGVD

c.	ELEVATION - Feet above National Geodetic Vertical Datum	
1.	Streambed at toe of dam	27.4
2.	Bottom of Cutoff	N/A
3.	Maximum Tailwater	N/A
4.	Normal Pool	35.9 Level encountered Dec. 9, 1980
5.	Full Flood Control Pool	N/A
6.	Spillway crest-without Stoplogs	
	Left spillway	33.5
	Right spillway	30.0
7.	Design Surcharge-Original Design	Unknown
8.	Top of Dam	42.0
9.	Test Flood Surcharge	42.5
d.	RESERVOIR - Length in feet	
1.	Normal Pool	5400
2.	Flood Control Pool	N/A
3.	Spillway crest pool (left)	5300 @ El. 33.5
	Spillway crest pool (right)	Unknown @ El. 30.0
4.	Top of Dam	6900
5.	Test Flood Pool	7000
e.	STORAGE - Acre-feet	
1.	Normal pool	550
2.	Flood control pool	N/A

3.	Spillway crest pool	300± @ El. 33.5
	Spillway crest pool	Unknown @ El. 30.0
4.	Top of Dam	1250
5.	Test flood pool	1300
f.	RESERVOIR SURFACE - (Acres)	
1.	Normal Pool	95
2.	Flood Control Pool	N/A
3.	Spillway crest	90± @ El. 33.5
	Spillway crest	Unknown @ El. 30.0
4.	Test Flood Pool	140
5.	Top of Dam	135
g.	DAM	
1.	Type	Earth embankment
2.	Length	660 feet
3.	Height	15 feet
4.	Top Width	Varies 30 ft. minimum
5.	Side slopes	
	Upstream Downstream	Approx. 2 H to 1 V Varies; vertical to 2 H to 1 V
6.	Zoning	Unknown
7.	Impervious Core	Unknown
8.	Cutoff	Unknown
9.	Grout curtain	Unknown
10.	Other	N/A

h. DIVERSION AND REGULATING TUNNEL	N/A
i. SPILLWAYS	
RIGHT SPILLWAY:	
1. Type	Stoplogs in Concrete slots
2. Length of Weir	8.8 ft; 2 - 4.4 ft bays
3. Crest	Varies from El. 42.0 to 30.0 NGVD
4. Gates	Stoplogs
5. Upstream channel	Not observed
6. Downstream channel	Stone Masonry
7. General	Flows into twin concrete box culverts 4.2 ft. wide x 3.6 ft. high, downstream invert 27.4 ft. NGVD
LEFT SPILLWAY:	
1. Type	Stoplogs in Concrete slots
2. Length of Weir	8.4ft; 2 - 4.2 ft bays
3. Crest	Varies from El. 42.0 to 33.5 ft. NGVD
4. Gates	Stoplogs
5. Upstream channel	Not observed
6. Downstream channel	Stone Masonry
7. General	Flows into 5 ft. diameter iron pipe Downsteam Invert 32.8 ft. NGVD
j. REGULATING OUTLETS	N/A

ENGINEERING DATA

SECTION 2

2.1 DESIGN DATA

There was no design data available for review for this dam. Inspection reports of the dam prepared by Plymouth County Commissioners and the Massachusetts Department of Public Works were reviewed. These contain sketches of the dam.

2.2 CONSTRUCTION DATA

No construction data was available for review. The name of the contractor responsible for construction is unknown.

2.3 OPERATIONAL DATA

Records of the reservoir level are not kept. The reservoir level is raised or lowered by the owner's foreman in response to the operational demands of the cranberry bogs downstream.

2.4 EVALUATION OF DATA

a. AVAILABILITY

Data reviewed was provided by the Plymouth County Commissioners and by the Massachusetts Department of Public Works. A list of the available reference material and their location is given in Appendix B.

b. ADEQUACY

The lack of depth of engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and

construction data, but is based primarily on visual inspection, past performance history, hydraulic and hydrologic calculations and sound engineering judgment.

c. VALIDITY

No design plans were reviewed, however inspection sketches reviewed appear to represent fairly existing conditions at the time of the visual inspection.

VISUAL INSPECTION

SECTION 3

3.1 FINDINGS

a. GENERAL

The visual inspection of the dam was conducted on December 9, 1980. At the time of inspection the level of the pond was approximately 36 ft. NGVD or approximately 6 feet below the top of the dam. The general condition of the dam at the time of inspection was poor.

b. DAM

The dam consists of an earth embankment with a vertical stone masonry wall over a portion of the downsteam face.

The crest of the dam consists primarily of medium to fine sand. Little or no vegetation is growing along the roadway which occupies the middle third of the crest. Grass, brush and trees are growing along the upstream and downstream edge of the crest (Photo # 1). The crest to the left of the left outlet structure is covered with grass and large trees. On the left side of the dam, a large overgrown linear depression which appeared to be an old channel was observed which extended from the reservoir edge approximately 90 feet parallel to the edge of the reservoir toward the downstream toe of the dam. The entrance to the channel adjacent to the reservoir is blocked up and covered with trees and brush. No outlet to the channel could be located during the site visit. At the time of inspection, no information was available on the previous uses of the apparent channel.

The upstream slope of the dam consists of embankment soil with no evidence of riprap protection and is covered with brush and trees up to 24 inches in diameter (Photo # 1). The slope is quite irregular and appears to have experienced widespread erosion. Numerous erosion gullies up to 1 ft. deep were evident along the slope and adjacent to the concrete intake and spillway structure (Photos # 2 & # 3).

The downstream slope of the dam to the right of the old plugged outlet consists of embankment soil and is covered with grass, brush and trees up to 20 inches in diameter. A small stone wall, 2.5 ft. high, was observed at several locations on the slope near the downstream toe of the dam. Two large excavations were observed at the toe of the dam near the right end of the dam. The excavations were approximately 15 ft. wide, 4 ft. deep, and the surface was covered with leaves and brush. At the time of the site inspection no information was available on the reason for these excavations. To the southeast of the right spillway, a wet area approximately 15 ft. long was observed just downstream from the toe of the dam with no visible evidence of flow.

In the vicinity of the old plugged outlet, the downstream soil slope has been replaced with a vertical stone masonry wall for the full height of the dam (Photo # 4). Most of the wall is mortared except for a 50 ft. unmortared section near the plugged outlet. The wall has tilted up to 6 inches in the downstream direction (Photo # 5). Portions of the wall appear to have been repointed recently.

Standing water is present near the base of the downstream

wall in the vicinity of the plugged outlet pipe. The water contains numerous orange flocs with no evidence of the movement of fines. The base of the former outlet channel in the vicinity of the downstream wall is covered with brush, grass, and small saplings (Photo # 4).

One animal burrow, 12 inches in diameter and approximately 15 inches deep, was noted on the crest of the dam to the left of the left outlet structure.

c. APPURTENANT STRUCTURES

The left spillway is located near the left end of the dam and consists of stoplogs in a concrete intake structure and a 5 ft. diameter iron pipe which empties into a channel of approximately vertical cut stone masonry block training walls (Photos # 6 & # 7). The concrete intake structure is in fair condition. Planking over access panels to the intake is rotted in places. Stoplogs were in fair condition.

The right spillway includes a concrete intake structure controlled by stoplogs which is in good condition (Photo # 1 & # 2). Flow from the intake structure passes into 4.2 ft. wide by 3.6 ft. high concrete culverts which pass through the dam and exits at the downstream toe. The interior of the box culverts were visually examined and are in good condition (Photo # 8). Stoplogs are in fair condition. Some erosion of the embankment has occurred near the downstream toe adjacent to the concrete box culvert and at the upstream intake structure.

The old outlet works is located approximately 100 ft. northwest of the left outlet. Both intake and outlet appear to have been plugged and were not visible during the site visit (Photos # 4 & # 9). The downstream channel bottom near the old outlet works was covered with water containing numerous orange colored flocs with no flow evident.

A 22 inch diameter cast iron pipe was noted next to the 5 ft. diameter pipe (Photo # 7). The purpose of this pipe could not be determined.

A 4 in. cast iron pipe was noted approximately 8 ft. above the base of the masonry wall south of the old plugged outlet. The purpose of this pipe could not be determined.

d. RESERVOIR AREA

No evidence of significant sedimentation in the reservoir was observed. No evidence of slope instability was apparent in the immediate vicinity of the dam.

e. DOWNSTREAM CHANNEL

The outlet channel for the left outlet is comprised of cut-stone masonry channel with approximately vertical training walls. The training walls are in fair condition with some indication of distortion and missing blocks. The flow falls from the iron pipe to this masonry channel then passes under a small wood plank foot bridge and joins an adjacent channel coming from the plugged outlet works.

The outlet channel for the right outlet consists of

nearly vertical training walls which are comprised of cobbles and boulders. The channel passes through a concrete culvert underneath the adjacent roadway and into the adjacent cranberry bogs.

The channel downstream of the old outlet works consists of cut-stone masonry walls. The downstream training walls are generally in fair condition with some of the cap blocks having fallen into the channel. The channel bottom is covered with logs, brush and trees up to 4 inches in diameter growing on the channel bottom. This channel flows into a box culvert and then joins with the outlet channel of the left outlet.

3.2 EVALUATION

On the basis of the visual inspection the dam is judged to be in poor condition.

The wet area at the downstream toe to the right of the plugged outlet works may be evidence that the line of seepage through the dam exits at the toe, a condition which could lead to a piping failure if the embankment or foundation soils are susceptible to piping.

Trees growing on the embankment and next to the downstream toe of the dam could be a cause of seepage and piping problems if a tree falls over and pulls out its roots or if a tree dies or is cut and its roots rot.

Lack of vegetation over a large portion of the crest of the dam makes the crest susceptible to erosion if the dam should

be overtopped.

An animal burrow on the crest of the dam could lead to seepage and piping problems if not properly plugged.

The lack of riprap on the upstream slope in the normal range of reservoir levels has contributed to extensive slumping and erosion of the upstream slope. Continued erosion could lead to instability and possible breaching of the dam.

Tilt and displacement of the downstream stone masonry wall near the spillway outlet works could lead to collapse of the wall if allowed to continue.

The purpose of the 22 inch and 4 inch pipes at the dam is unknown, therefore the affect of these items on the dam's long term stability cannot be assessed.

The excavations at the downstream slope reduce the dam cross section and increase erosion of the slope.

OPERATIONAL AND MAINTENANCE PROCEDURES

SECTION 4

4.1 OPERATIONAL PROCEDURES

a. GENERAL

The dam is used primarily for irrigation and recreational purposes. The water impounded by the dam is used to irrigate cranberry bogs downstream of the dam. A local rod and gun club has leased fishing rights from the owner of Tihonet Pond and uses this pond for water related recreational activity.

The dam is operated in conjunction with another dam, Tihonet Pond No. 1 Dam to the east of this site. The outlets of both dams are regulated by personnel from A.D. Makepeace Co. to control the flow of water into the bogs as required for growing.

Occasionally the water level is lowered by removing stoplogs to control trash fish and for maintenance or repair to the structures.

b. DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no formal warning system in effect.

4.2 MAINTENANCE PROCEDURES

a. GENERAL

The dam is visited on a continuous basis, by the owners' operating personel who has responsibility for all dams in his assigned area.

b. OPERATING FACILITIES

The stoplogs at the left and right spillways are the operational portions of this dam requiring maintenance. These items are observed on a daily basis.

4.3 EVALUATION

Present operational procedures should be modified to include a formal warning system: The dam is monitored during periods of heavy rainfall presently, however, a formal procedure for notifying downstream authorities in the event of an emergency should be prepared.

Maintenance procedures for the dam should be modified to include inspection and maintenance of the dam embankment as well as the spillways. A written set of maintenance procedures should be prepared and implemented. These procedures should include monthly inspections, periodic removal of brush from the dam slopes and crest and correction of any minor erosion noted during inspections.

A technical inspection of the dam should be performed once a year by a qualified registered engineer.

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

SECTION 5

5.1 GENERAL

Tihonet Pond No. 2 Dam is located in a rural area of Wareham, Massachusetts. The reservoir surface is about 95 acres at normal level and has a drainage area of 8.1 square miles.

A second dam is located on Tihonet Pond, Tihonet Pond No. 1 Dam, approximately 1800 ft. to the east of Tihonet Pond No. 2 Dam. These dams are operated in conjunction with one another. For the purposes of this study the outlets from Tihonet Pond No. 1 Dam were considered closed. Weir flow over Tihonet Pond No. 1 Dam was considered in the Test Flood analysis.

5.2 DESIGN DATA

No design data was available for this report.

5.3 EXPERIENCE DATA

No data is available on past flood experiences.

5.4 TEST FLOOD ANALYSIS

Based on the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, the size of the dam is intermediate. The dam has approximately 1250 acre-ft of storage. Based on dam failure analysis and the above Guidelines the dam is classified as "High" hazard potential.

Based on the Corps of Engineers' guidelines the Test Flood

should be the Probable Maximum Flood (PMF). Use of the Corps of Engineers guide curves for "flat & coastal" terrain results in a peak inflow of about 6000 cfs or about 750 cfs/sq. mi. The inflow was then routed through the reservoir using the Corps of Engineers' "Surcharge Routing Alternative" and resulted in an attenuated peak test flood of 5500 cfs. For the routing calculations the reservoir was assumed to be at normal pool elevation, the elevation encountered during the visual inspection, and the pond was expanded in area during the rise. The test flood was found to rise to a pond elevation of 42.5 ft. NGVD, which is 0.5 ft. above the dam embankment (El. 42.0 ft. NGVD). The spillways pass about 10% of the Test Flood.

5.5 DAM FAILURE ANALYSIS

A dam failure analysis was made using the "Rule of Thumb Guidance" provided by the Corps of Engineers. Failure was assumed with the water level at the top of the dam (El. 42.0 ft. NGVD) and assumed breach size was 192 feet. Spillways were not included in the breach. Pre-failure flow was about 500 cfs as compared with post-failure flow of about 19,000 cfs. Based on this analysis and Corps of Engineers' guidelines, the dam is classified as having a "High" hazard potential: a breach of the dam may damage about 8 buildings and potentially cause the loss of more than a few lives. The prime impact area is located near the dam where 3 mill buildings will receive over 7 ft. of flooding and Farm to Market Road will be overtopped by the flood wave.

If the mill buildings are inhabited at the time of failure loss of life may occur. On the north outlet one house will receive major flooding with possible loss of life.

Further downstream damage will consist of flooding to 3 commercial/industrial buildings, 1 pump station, and 1 road. Post-failure flooding at the commercial/industrial structure will be one to five feet compared to no flooding prior to the assumed failure. The pump house will be inundated and the road washed out by five feet of flooding. If any of these structures or roadway are inhabited at the time of flooding loss of life may occur. The flood wave will then become attenuated by Maple Swamp.

Table 1 summarizes the results of the assumed dam failure. The dam breach calculations and a map of the approximate downstream impact area are shown in Appendix D.

The table below summarizes the downstream effect of failure of Tihonet Pond Dam No. 2:

Location no. (see map)	Distance D/S of Dam (ft)	Number of Structures	Level Above Stream (ft)	Flow (CFS) Stage (Ft. above Stream) Before Failure	After Failure	Comments
1	105 - 422	3 mill buildings	4-12	234/1.5	18,988/19.3	Major damage to mill buildings. Significant danger of loss of life.
		road	4-5			Probable wash-out.
		1 house	4-5			Major damage to 1 house. Significant danger of loss of life.
2	422-615	road	5	234/1.4	18,270/14	Probable wash-out.
	615	pump station	5-6			Major damage to pump sta.
		1 house	15-16			
3	615-1,675'	3(probable) commercial/ industrial bldgs.	5-10	234/0.3	17,984/10.2	Some damage to (probable) commercial/industrial buildings. Some danger of loss of life.
4	1,700			234/0.5	15,073/7.8	Flood wave attenuating in Maple Swamp.
	2,629			234/0.5	11,266/6.5	
	2,835	road	15-26			Some erosional damage as flood wave impacts roadway & passes through waterway openings.

Table 1 - Summary of Downstream Flooding

EVALUATION OF STRUCTURAL STABILITY

SECTION 6

6.1 VISUAL OBSERVATIONS

The visual observations did not disclose evidences of overall instability, however, the downstream stone masonry wall has tilted locally indicating a potential future instability.

6.2 DESIGN AND CONSTRUCTION DATA

There was no design and construction data available at the time of inspection.

6.3 POST-CONSTRUCTION CHANGES

Field inspection indicates a number of post-construction changes made on this dam. It appears that the left and right outlets are not original, an outlet has been plugged, and an apparent discharge channel has been blocked off. No design drawings were available for these post-construction changes.

There is reference on one of the state inspection reports that the concrete spillway structure on the left side of the dam was replaced in approximately 1954 or 1955. No design drawings were available for the post-construction repair.

6.4 SEISMIC STABILITY

The dam is located in Seismic Zone 2 and in accordance with the Phase 1 inspection guidelines does not warrant seismic stability analysis.

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

SECTION 7

7.1 DAM ASSESSMENT

a. CONDITION

Based on the visual inspection, the dam is judged to be in poor condition. The following conditions are indicative of potential long-term problems:

1. A wet area adjacent to the downstream toe of the dam indicates that the line of seepage through the dam exits at or near the toe, a condition which could lead to a piping failure if the embankment or foundation soils are susceptible to piping.

2. Trees growing on the embankment and the downstream toe of the dam could be a cause of seepage and piping problems if one of the trees blows over and pulls out its roots or if a tree dies or is cut and its roots rot.

3. Continued erosion and slumping of the upstream slope of the dam could lead to serious seepage and piping problems.

4. Bulging of the downstream masonry wall to the right of the spillway works could threaten the integrity of the dam.

5. Excavations at the downstream slope of the dam reduce the dam cross-section and increase erosion of the slope.

b. ADEQUACY OF INFORMATION

The information available is such that the assessment of this dam must be based primarily on the results of the visual

inspection which is adequate for the purposes of the Phase 1 inspection.

c. URGENCY

The owner should implement the recommendations in 7.2 and 7.3 within one year after the receipt of this report.

7.2 RECOMMENDATIONS

The following recommendations should be carried out under the direction of a qualified, registered engineer.

1. Investigate the cause of the wet area adjacent to the downstream toe near the right spillway and the wet area in the downstream channel at the plugged outlet, design and oversee construction of remedial measures as required.

2. Specify procedures for removing the trees and root systems from the embankment and an area 20 ft. from the toe of the dam; oversee the backfilling operation.

3. Design and oversee construction of erosion protection for the upstream face and crest of the dam.

4. The stability of the bulged area of the downstream masonry wall to the right of the spillway works should be analyzed and stabilization measures should be undertaken as required. Appropriate drainage features should be included in any stabilization measures.

5. Prepare a plan of all pipes (including the 22 " pipe near the left outlet) and other structures within the vicinity of the dam embankment which may provide seepage paths through the dam.

6. Specify procedures for filling erosion gullies and animal burrows, oversee the backfilling operation.

7. Investigate the need for backfilling the excavated areas near the right end of the dam, specify remedial measures as required.

8. Perform a detailed hydrologic-hydraulic investigation to assess further the potential of overtopping the dam and the need for and the means to increase project discharge capacity.

7.3 REMEDIAL MEASURES

a. OPERATION AND MAINTENANCE PROCEDURES

1. Institute a formal downstream warning system to include monitoring the dam during extremely heavy rains, and procedures for notifying downstream authorities in the event of an emergency.

2. Engage a qualified, registered engineer to make a comprehensive technical inspection of the dam once every year.

3. Remove all brush from the dam embankment.

4. Establish an on-going maintenance program including but not limited to: removal of brush from the dam embankment and discharge channels, correction of minor erosion at dam and repair of animal burrows on dam slopes.

7.4 ALTERNATIVES

There are no practical alternatives to the above recommendations.

APPENDIX A

VISUAL CHECKLIST WITH COMMENTS

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT TIHONET POND NO.2 DAM

DATE DECEMBER 9, 1980
TIME 1:00 P.M.
WEATHER CLEAR, COLD
W.S. EL. 35.9 U.S.
27.4 D.S.

PARTY:

1. John F. Modzelewski P.E. ASEC Corporation - Civil/Structural
2. Richard M. Baker Vollmer Associates Inc. - Hydrologist
3. Richard F. Murdock P.E. Geotechnical Engineers Inc. - Geotechnical
4. Richard W. Turnbull Geotechnical Engineers Inc. - Geotechnical

PROJECT FEATURE	INSPECTED BY
1. Dam Embankment	GEI
2. Dike Embankment	None observed
3. Outlet Works - Intake Channel Intake Structure	ASEC, GEI
4. Outlet Works - Control Tower	None observed
5. Outlet Works - Transition & Conduit	ASEC
6. Outlet Works - Outlet Structure & Outlet Channel	ASEC, GEI
7. Outlet Works - Spillway Weir, Approach & Discharge Channels	ASEC, GEI
8. Outlet Works - Service Bridge	ASEC

PERIODIC INSPECTION CHECKLIST

PROJECT TIHONET POND NO. 2 DAM — DATE Dec. 9, 1980

PROJECT FEATURE see below — NAME JFM, RFM, RFT

DISCIPLINE Civil Engineer, Geotechnical Engineer — NAME

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	El. 42.0 ± NGVD
Current Pool Elevation	El. 36.0 ± NGVD
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed1
Pavement Condition	No pavement.
Movement or Settlement of Crest	None observed; minor undulations.
Lateral Movement	None observed.
Vertical Alignment	Sta 4+05 and 4+35; stone wall displaced d/s 3-6"; general d/s bulge in wall from top to about the middle
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	Minor-moderate erosion adjacent to and behind former & existing concrete outlet works.
Indications of Movement of Structural Items on Slopes	None observed.
Trespassing on Slopes	Large pit on crest Sta 6+15 to 6+95; pit begins approx. 15' back from reservoir & is approx 80' long by 25' wide by 5' deep; walls covered w/slag & bottom covered w/(dumped?) vegetative debris; approx. smaller pits on d/s slope at 0+05 to 0+18 & 0+20 to 0+35. Occasional footpaths along N/S reservoir banks.
Sloughing or Erosion of Slopes or Abutments	Extensive moderate erosion and sloughing of N/S face; oversteepening & undercutting reservoir banks.
Rock Slope Protection - Riprap Failures	None observed.
Unusual Movement or Cracking at or Near Toe	Wet area at top of d/s slope Sta 2+75 may indicate seepage. Water leaking from 4" drainage pipe located 6' below top of d/s stone wall at Sta 3+80. Minor seepagethru former outlet conduit.
Unusual Embankment or Downstream Seepage	None observed.
Piping or Boils	None observed.
Foundation Drainage Features	None observed.
Toe Drains	None observed.
Instrumentation System	None observed.
Vegetation	Crest; generally barren; some pine needles grass, lt brush d/s. lt to dense brush d/s variable density brush & trees; floor has leaves, pine needles, brambles & humus.

PERIODIC INSPECTION CHECKLIST

PROJECT TIHONET POND NO. 2 DAM DATE Dec. 9, 1980

PROJECT FEATURE see below NAME --

DISCIPLINE -- NAME --

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	None.
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or Near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	
Vegetation	

PERIODIC INSPECTION CHECKLIST

PROJECT TIHONET POND NO. 2 DAM DATE Dec. 9, 1980

PROJECT FEATURE see below NAME JFM, RFM, RWT

DISCIPLINE Civil Engineer, Geotechnical Engineer NAME

AREA EVALUATED	CONDITION
EXISTING OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	Not observed (under water).
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	None
Debris	N/A
Condition of Concrete Lining	N/A
Drains or Weep Holes	None observed.
b. Intake Structure - North (Right)	
Condition of Concrete	Good - some erosion of concrete along inside slots, no reinforcing visible
Flashboards ~~Stop Logs~~ and Slots	Fair - Flashboards Slots in good condition
Intake Structure - South (Left)	
Condition of Concrete	Good
Flashboards and Slots	Fair - Flashboards Slots in good condition
Other	Southern wood access cover partially rotted

4 A

PERIODIC INSPECTION CHECKLIST

PROJECT TIHONET POND NO. 2DAM DATE Dec. 9, 1980

PROJECT FEATURE see below NAME JFM, RFM, RWT

DISCIPLINE Civil Engineer, Geotechnical Engineer NAME

AREA EVALUATED	CONDITION
FORMER OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	Not observed (under water).
a. Approach Channel	
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	None observed.
b. Intake Structure	Plugged
Condition of Concrete	
Stop Logs and Slots	

PERIODIC INSPECTION CHECKLIST

PROJECT TIHONET POND NO. 2 DAM — DATE Dec. 9, 1980

PROJECT FEATURE see below — NAME --

DISCIPLINE -- — NAME --

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	None
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

6

PERIODIC INSPECTION CHECKLIST

PROJECT TIHONET POND NO. 2 DAM DATE Dec. 9, 1980

PROJECT FEATURE see below NAME JFM

DISCIPLINE Civil/Structural Engineer NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
NORTH OUTLET: (Right)	
General Condition of Concrete	Good
Rust or Staining on Concrete	None observed
Spalling	None observed
Erosion or Cavitation	None observed
Cracking	None observed
Alignment of Monoliths	N/A
Alignment of Joints	None visible
Numbering of Monoliths	N/A
OUTLET WORKS - TRANSITION AND CONDUIT	
SOUTH OUTLET: (Left)	
General Condition of Conduit	Pitted cast iron, fair condition Invert broken at downstream end
Transition	Not observed

PERIODIC INSPECTION CHECKLIST

PROJECT TIHONET POND NO. 2 DAM DATE Dec. 9, 1980

PROJECT FEATURE see below NAME JFM

DISCIPLINE Civil Engineer NAME

AREA EVALUATED	CONDITION
EXISTING OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	North Outlet: (Right)
General Condition of Concrete	No outlet Structure; Conduit merely ends
Rust or Staining	South Outlet: (Left)
Spalling	No outlet structure; Conduit ends
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	
Channel : South Outlet Discharge Channel	
General Condition	Good
Loose Rock or Trees Overhanging Channel	Occasional cobble in stone masonry sidewalls , no trees overhanging channel
Floor of Channel	Very occasional cobble in concrete channel
Other obstructions	None
Channel : North Outlet Discharge Channel	
General Condition	
Loose Rock Overhanging Channel	
Trees Overhanging Channel	
Floor of Channel	
Other Obstructions	
Other Comments	

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PERIODIC INSPECTION CHECKLIST

PROJECT TIHONET POND NO. 2 DAM DATE Dec. 9, 1980

PROJECT FEATURE see below NAME JFM, RFM, RWT

DISCIPLINE Civil Engineer, Geotechnical Engineer NAME

AREA EVALUATED	CONDITION
FORMER OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	N/A outlet plugged
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	None observed
Channel	
Loose Rock or Trees Overhanging Channel	Unmortared channel wall base in places; A tree to 4" dia. growing in channel floor.
Condition of Discharge Channel	Left and right walls of channel generally intact; some blocks have fallen into channel; channel partially blocked with bits of logs, brush & stone blocks; channel bottom partially sedimented and ponded and is supporting light brush, grass and weeks.

PERIODIC INSPECTION CHECKLIST

PROJECT TIHONET POND NO. 2 DAM DATE Dec. 9, 1980

PROJECT FEATURE see below NAME JFM, RFM, RWT

DISCIPLINE Civil Engineer, Geotechnical Engineer NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	No spillway - see OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL
a. Approach Channel	
General Condition	
Loose Rock Overhanging Channel	
Trees Overhanging Channel	
Floor of Approach Channel	
b. Weir and Training Walls	
General Condition of Concrete	
Rust or Staining	
Spalling	
Any Visible Reinforcing	
Any Seepage or Efflorescence	
Drain Holes	
c. Discharge Channel	
General Condition	
Loose Rock Overhanging Channel	
Trees Overhanging Channel	
Floor of Channel	
Other Obstructions	
Other Comments	

PERIODIC INSPECTION CHECKLIST

PROJECT TIHONET POND NO. 2 DAM DATE Dec. 9, 1980

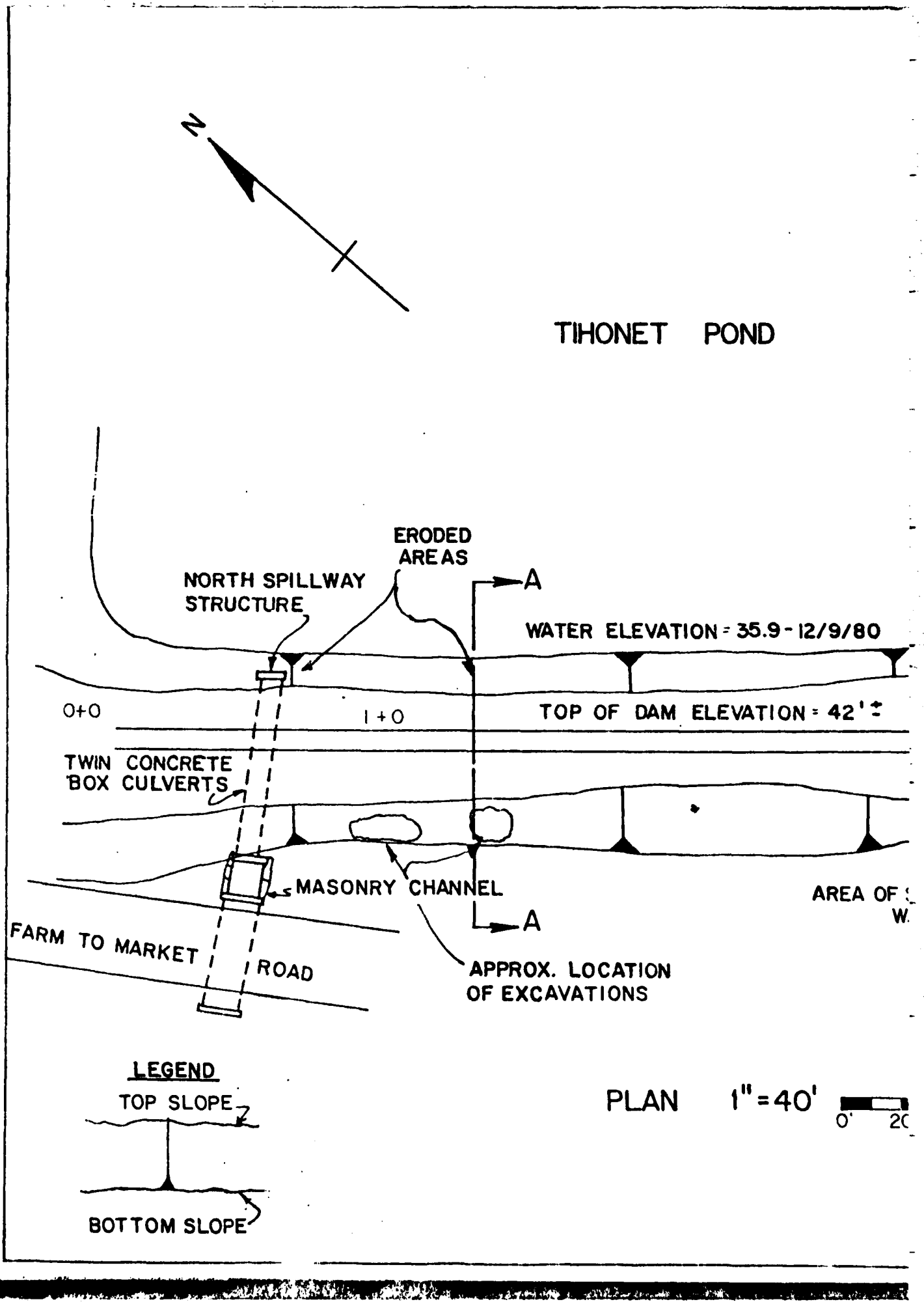
PROJECT FEATURE see below NAME --

DISCIPLINE -- NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	None
a. Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Underside of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

APPENDIX B

ENGINEERING DATA


N
TIHONET POND
ERODED AREAS
NORTH SPILLWAY STRUCTURE
A
WATER ELEVATION = 35.9 - 12/9/80
0+0
1+0
TOP OF DAM ELEVATION = 42' ±
TWIN CONCRETE BOX CULVERTS
MASONRY CHANNEL
AREA OF
W.
A
FARM TO MARKET
ROAD
APPROX. LOCATION OF EXCAVATIONS
LEGEND
TOP SLOPE
BOTTOM SLOPE
PLAN 1" = 40'
0'
20

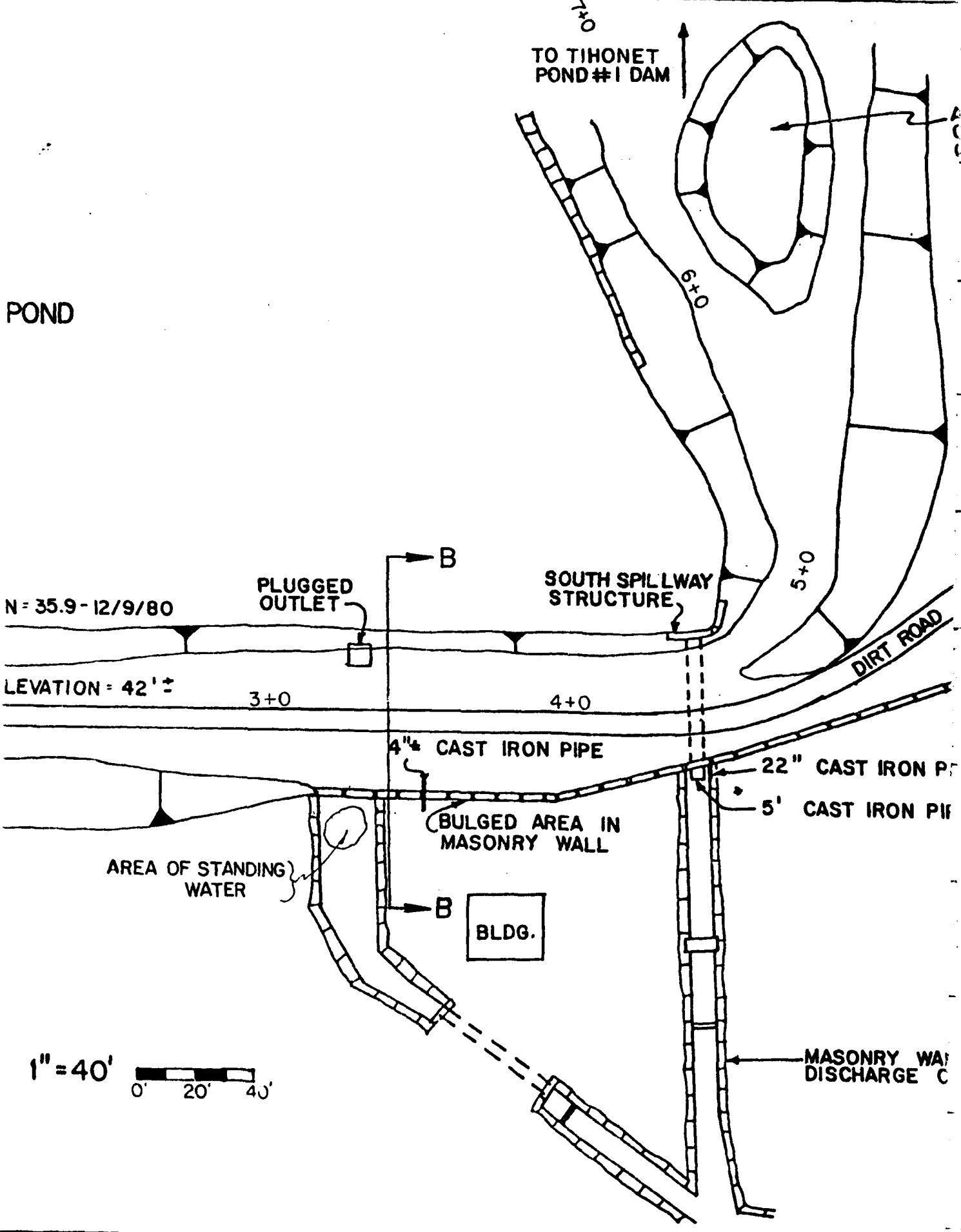
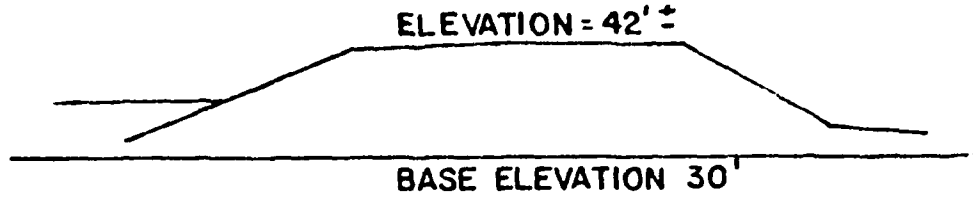

7+0
TO TIHONET
POND #1 DAM
POND
6+0
5+0
B
PLUGGED
OUTLET
SOUTH SPILLWAY
STRUCTURE
N = 35.9 - 12/9/80
DIRT ROAD
LEVATION = 42' ±
3+0
4+0
4" CAST IRON PIPE
22" CAST IRON P
5' CAST IRON PI
BULGED AREA IN
MASONRY WALL
AREA OF STANDING
WATER
B
BLDG.
1" = 40'
0'
20'
40'
MASONRY WA
DISCHARGE C

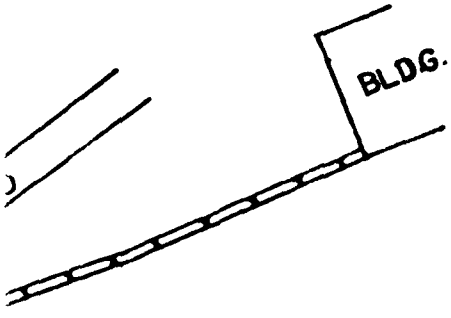
FIG. 2

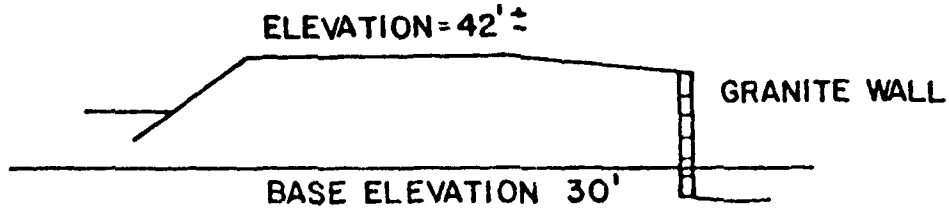
APPARENT
OLD DISCHARGE
CHANNEL



SECTION A-A

SCALE 1" = 20'





PIPE

PIPE

SECTION B-B

SCALE 1" = 20'

WALLED
CHANNEL

ASEC CORPORATION *CONSULTING ENGINEERS* BOSTON, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND *CORPS OF ENGINEERS* WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

TIHONET POND #2 DAM
WAREHAM, MASS.

MASS. #00030

DRAWN	CHECKED	APPROVED	SCALE	DATE	PAGE
		J.F.M.	AS SHOWN	12-9-80	B-1

LIST OF REFERENCES

REFERENCE	LOCATION
1. Inspection Report - Dams & Reservoirs Dam # 7-12-310-7 Dated 10-3-75	Mass. Dept. of Environmental Quality Engineering Division of Waterways 1 - 11 Winter Street Boston, MA 02110 Tel. (617) 727-4797
2. Inspection of Dams & Reservoirs Dam # 15 Dated July, 1936	Plymouth County Commissioners Highway Department South Russel Street Plymouth, MA 02360

INSPECTION REPORT - DAMS AND RESERVOIRS

1. Location: ~~City~~/Town Wareham Dam No. 7-12-310-7

Name of Dam Tihonet Pond #2 Inspected by: K.B. Harrison & G.G. Burgess

Date of Inspection: 10-3-75

2. Owner/s: Per: Assessors ✓ Prev. Inspection 8-2-73

Reg. of Deeds _____ Pers. Contact _____

	Name	St. & No.	City/Town	State	Tel. No.
1.	A.D. Makepeace Co.	266 Main St	Wareham	Mass.	
	Name	St. & No.	City/Town	State	Tel. No.
	Name	St. & No.	City/Town	State	Tel. No.

3. Caretaker: (if any) e.g. superintendent, plant manager appointed by absentee owner, appointed by multi-owners.

Name	St. & No.	City/Town	State	Tel. No.

4. No. of Pictures taken: None

5. Degree of Hazard: (if dam should fail completely)*

1. Minor _____ 2. Moderate _____

3. Severe ✓ 4. Disastrous _____

*This rating may change as land use changes (future development)

6. Outlet Control: Automatic _____ Manual ✓

Operative: Yes ✓ No _____

Comments: Two Bay Conc. Flume w/ Flashboards & 6.0" metal outlet pipe

7. Upstream Face of Dam:

Conditions:

1. Good ✓ 2. Minor Repairs _____

3. Major Repairs _____ 4. Urgent Repairs _____

Comments: Numerous trees but dam has good height and extreme width 46'±.

Dam No. 7-12-310-7

8. Downstream Face of Dam:

Conditions:

1. Good ✓ 2. Minor Repairs _____

3. Major Repairs _____ 4. Urgent Repairs _____

Comments: Same as upstream face.

9. Emergency Spillway: Yes

Conditions:

1. Good ✓ 2. Minor Repairs _____

3. Major Repairs _____ 4. Urgent Repairs _____

Comments: Two bay conc. flume w/ flashboards & twin 4.5' x 4' conc. box culv. outlets.

10. Water Level at Time of Inspection:

6.2 ft. _____ above ✓ below top of dam.

✓ principal spillway _____ other

11. Summary of Deficiencies Noted:

Growth (Trees & Brush) on Embankment Yes

Animal Burrows & Washouts No

Damage to Slopes or Top of Dam No

Cracked or Damaged Masonry No

Evidence of Seepage No

Evidence of Piping No

Erosion No

Leaks Yes - minor through flashboards

Trash and/or Debris Impeding Flow No

Clogged or Blocked Spillway No

Other _____

Dam No. 7-12-310-7

12. Remarks & Recommendations (fully explain)

This dam is in good general condition except for numerous trees on embankment. It is questionable wether trees need cutting as dam has extreme height & width. Minor leakage noted through flashboards.

13. Overall Condition:

1. Safe ✓
2. Minor Repairs Needed
3. Conditionally Safe - Major Repairs Needed
4. Unsafe
5. Reservoir Impoundment no Longer Exists (explain)

   Recommend Removal from Inspection List

OC FILE

INSPECTION REPORT - DAMS AND RESERVOIRS

1. Location: ~~City~~/Town WAREHAM Dam No. 7-12-310-7

Name of Dam THORNET POND #2 Inspected by: JOHN DELANEY & J. MCGINNIS

Date of Inspection 8-2-73

2. Owner/s: Per: Assessors ✓ Prev. Inspection 1-22-71

Reg. of Deeds _____ Pers. Contact _____

	Name	St.& No.	City/Town	State	Tel.No.
1.	A.D. MAKEPEACE CO.	246 MAIN ST.	WAREHAM,	MASS.	
	Name	St.& No.	City/Town	State	Tel.No.
	Name	St.& No.	City/Town	State	Tel.No.

3. Caretaker: (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

Name	St.& No.	City/Town	State	Tel.No.

4. No. of Pictures taken NONE

5. Degree of Hazard: (if dam should fail completely)*

1. Minor _____ 2. Moderate _____

3. Severe ✓ 4. Disastrous _____

*This rating may change as land use changes (future development)

6. Outlet Control: Automatic _____ Manual ✓

Operative ✓ yes; _____ No

Comments: FLASHBOARDS

7. Upstream Face of Dam: Condition:

Conditions:

1. Good ✓ 2. Minor Repairs _____

3. Major Repairs _____ 4. Urgent Repairs _____

Comments: MANY TREES ON EMBANKMENT, BUT DAM WIDTH IS SUFFICIENT SO AS NOT TO WARRANT THEIR REMOVAL

Dam No. 2-12-310-7

8. Downstream Face of Dam:
Condition: 1. Good ✓ 2. Minor Repairs _____
3. Major Repairs _____ 4. Urgent Repairs _____
Comments: SAME AS ITEM #7

9. Emergency Spillway:
Condition: 1. Good ✓ 2. Minor Repairs _____
3. Major Repairs _____ 4. Urgent Repairs _____
Comments: _____

10. Water Level at Time of Inspection:
½ ft. above _____. below ✓. top of dam _____
principal spillway ✓. other _____.

11. Summary of Deficiencies Noted:
Growth (Trees & Brush) on Embankment YES
Animal Burrows & Washouts NO
Damage to Slopes or Top of Dam NO
Cracked or Damaged Masonry NO
Evidence of Seepage NO
Evidence of Piping NO
Erosion NO
Leaks NO
Trash and/or Debris Impeding Flow NO
Clogged or Blocked Spillway NO
Other _____

12. Remarks & Recommendations: (Fully Explain)

THIS DAM IS IN GOOD GENERAL CONDITION

13. Overall Condition:

1. Safe ✓
2. Minor Repairs Needed
3. Conditionally Safe - Major Repairs Needed
4. Unsafe
5. Reservoir Impoundment no Longer Exists (explain)

   Recommend Removal from Inspection List

DESCRIPTION OF DAM

DISTRICT 7

Submitted by JOHN DELANO Dam No. 7-12-310-7

Date 8-2-73 ~~City~~/Town WAREHAM

Name of Dam TIHONET POND #2

1. Location: Topo Sheet No. 45C

Provide 8½" x 11" in clear copy of topo map with location of Dam clearly indicated.

2. Year Built _____ Year/s of Subsequent Repairs _____

3. Purpose of Dam: Water Supply _____ Recreational _____

Irrigation V Other _____

4. Drainage Area: 10 Sq.Mi. _____ Acres

5. Normal Ponding Area: _____ Acres _____ Ave.Depth

Impoundment: 175,000,000 Gals. _____ Acre Ft.

6. No. and Type of Dwellings Located Adjacent to Pond or Reservoir

i.e. Summer Homes, etc. 1 HOME

7. Dimensions of Dam: Length 650 ET Max. Height 25 FT.

Slopes: Upstream Face VERT.

Downstream Face VERT.

Width Across Top 46 ET

8. Classification of Dam by Material:

Earth V Conc. Masonry _____ Stone Mason. _____

Timber _____ Rockfill _____ Other _____

DAM NO. 7-12-310-7

9.

A. Description of Present Land Usage Downstream of Dam:

100 % rural _____ % urban

B. Is there a storage area or flood plain downstream of dam which could accommodate the impoundment in the event of a complete dam failure ✓ yes _____ no

---

10.

Risk to Life and Property in Event of Complete Failure

No. of People 6

No. of Homes 2

No. of Businesses 0

No. of Industries 1 Type CRANBERRY

No. of Utilities 0 Type _____

Railroads 0

Other Dams 7-12-310-2

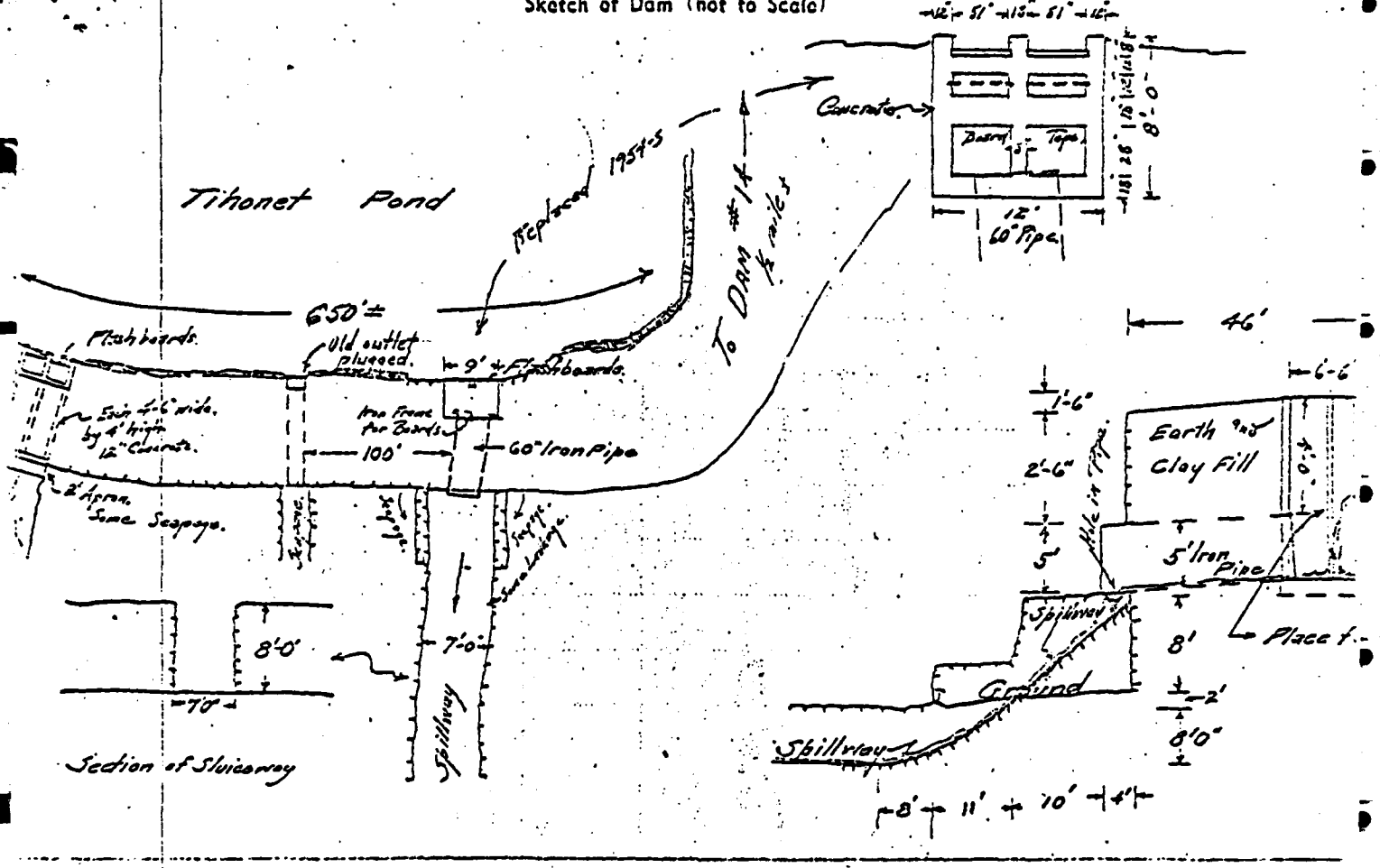
Other RTE. 25, RTE 28

11.

Attach sketch of dam to this form showing section and plan on an 8½" x 11" sheet.

7-12-310-7

Sketch of Dam (not to Scale)



DAM NO 15

COUNTY OF PLYMOUTH, MASSACHUSETTS
ENGINEERING DEPARTMENT
INSPECTION OF DAM AND RESERVOIRS

Inspector Bamber & Gfroerer Date July, 1936 City or Town Wareham

Location West side of Tihonet Pond – North Wareham

Owner A.D. Makepeace Co. Use Reservoir for Bogs

Material and Type Sand Dyke with Stone Facing

(Main Dam forming Tihonet Pond.)

Maximum Head in Feet (Full Pond Level to Bottom of Spillway) 25 feet

Length 650 feet Width 46 feet

Area of Watershed 10 Sq. Miles Capacity 175,000,000 Gallons

Length of Overflow or Spillway Outlets (Pipes or Flumes)

5' diam. Iron Pipe. (See #14)

Dam Constructed by Date

Recent Repairs Date

Evidence of Leakage Slight Leakage near spillway

Condition Good.

Topography of Country Below Flat – Cranberry Bogs and Parker Mills Pond.

Nature, extent, proximity, etc. of buildings, roads or other property in danger if failure should occur

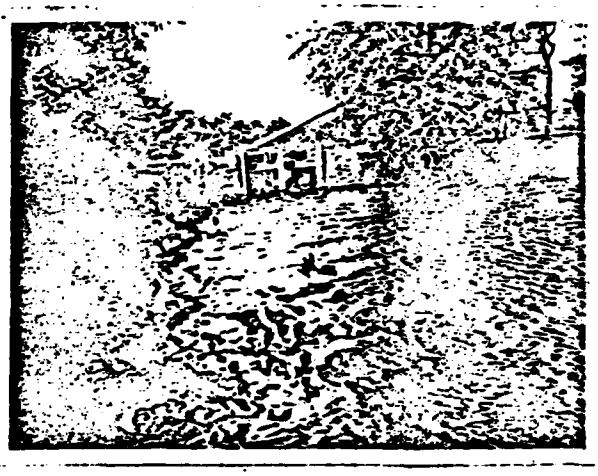
Complete failure (which is unlikely) would cause serious damage to two roads, damage a large acreage of Cranberry Bogs, shops and storerooms of the Makepeace Co. and the Tremont Nail Works Plant at Wareham Centre.

Remarks and Recommendations

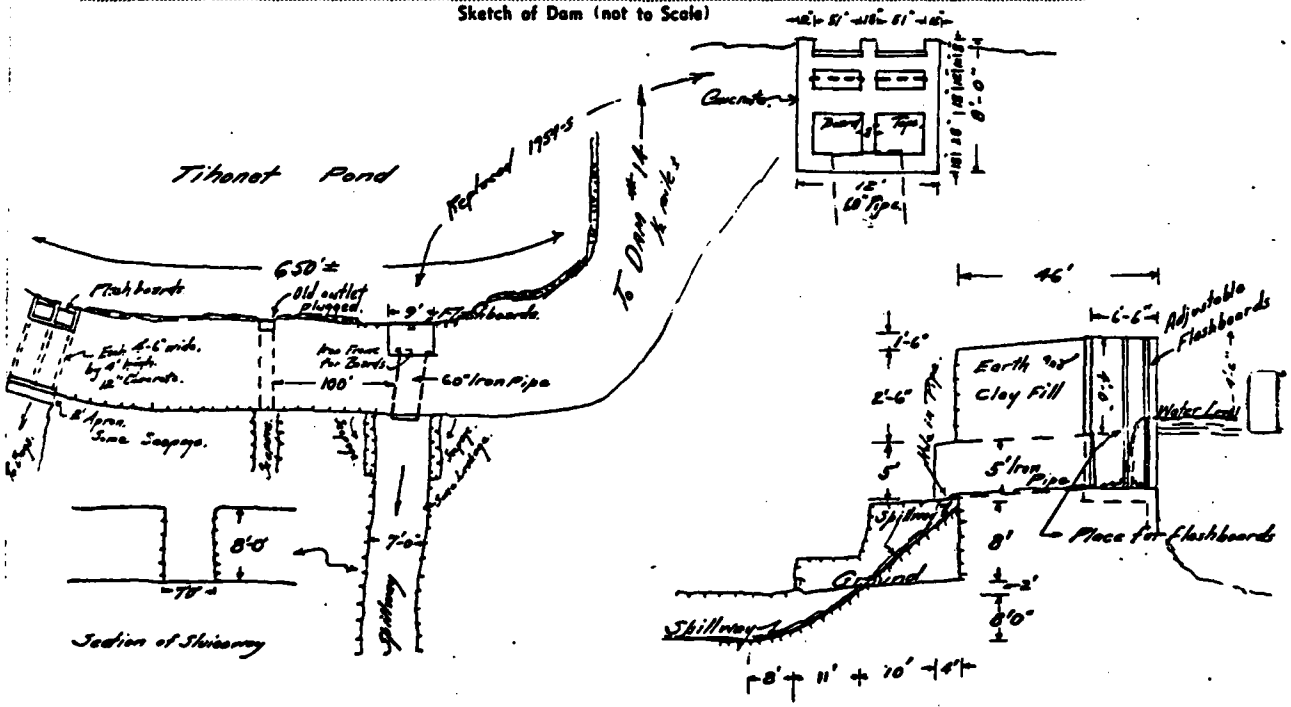
This Dam is in good Condition and is well maintained. Spillways ample in conjunction with #14 and with proper regulation.

Unchanged June 1938 & Feb 1939. Unchanged Dec. 1941. Unchanged Apr. Good – unchanged Nov. 1948. No changes Nov. 1949. Good-unchanged Sept. 1951. No changes Mar. 1953. Good condition Nov. 1955. Same – no changes June 1957. Good – sound Sept. 1959. Sound-good slope Sept. 1961. Good – no change Dec. 1965. Good – no change Nov. 1967. Good – no change Oct. 1969.

DAM NO 15



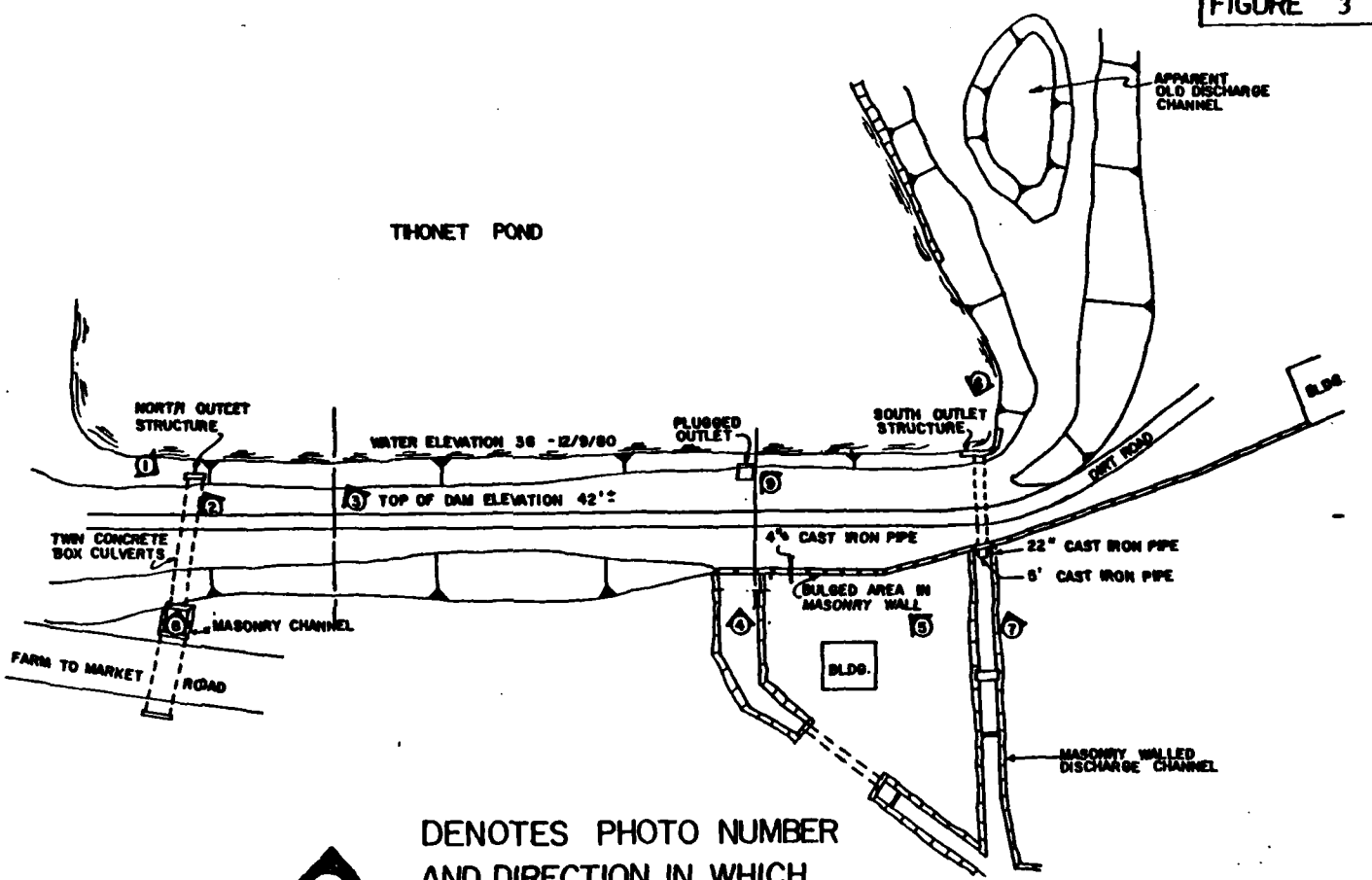
Sketch of Dam (not to Scale)



APPENDIX C

PHOTOGRAPHS

FIGURE 3



ASEC CORPORATION *CONSULTING ENGINEERS* BOSTON, MASS. FEBRUARY 1981	PHOTO LOCATION PLAN TIHONET POND NO. 2 DAM MA 00030	U.S. ARMY ENGINEER DIV. NEW ENGLAND *CORPS OF ENGINEERS* WALTHAM, MASS.

Photo # 1 Right Intake Structure and Upstream Dam Face

Photo # 2 Erosion near Right Intake Structure
(Rule extended 6 feet)

U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM , MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	TIHONET POND NO.2 DAM TR. TO WANKINCO RIVER WAREHAM, MASS. MA 00030 DECEMBER 9, 1980
ASEC CORP. CONSULTING ENGINEERS BOSTON , MASSACHUSETTS		

Photo # 3 Erosion at Upstream Dam Face
(Rule extended 6 feet)

Photo # 4 Masonry wall and channel
at Plugged Outlet

U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM , MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	TIHONET POND NO.2 DAM TR. TO WANKINCO RIVER WAREHAM, MASS. MA 00030 DECEMBER 9, 1980
ASEC CORP. CONSULTING ENGINEERS BOSTON , MASSACHUSETTS		

Photo # 5 Bulged wall at Downstream Face

Photo # 6 Left Outlet - Concrete Intake Structure

Photo # 7 Left Outlet - showing 5 ft. Iron Pipe, 22 inch Iron Pipe and Downstream Channel

Photo # 8 Right Outlet - Downstream face of 3.6 ft. high Twin Box Culverts

U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM , MASSACHUSETTS ASEC CORP. CONSULTING ENGINEERS BOSTON , MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	TIHONET POND NO.2 DAM TR. TO WANKINCO RIVER WAREHAM, MASS. MA 00030 DECEMBER 9, 1980

Photo # 9 Plugged intake of former outlet structure

Photo # 10 Crest - Tihonet Pond #1 Dam

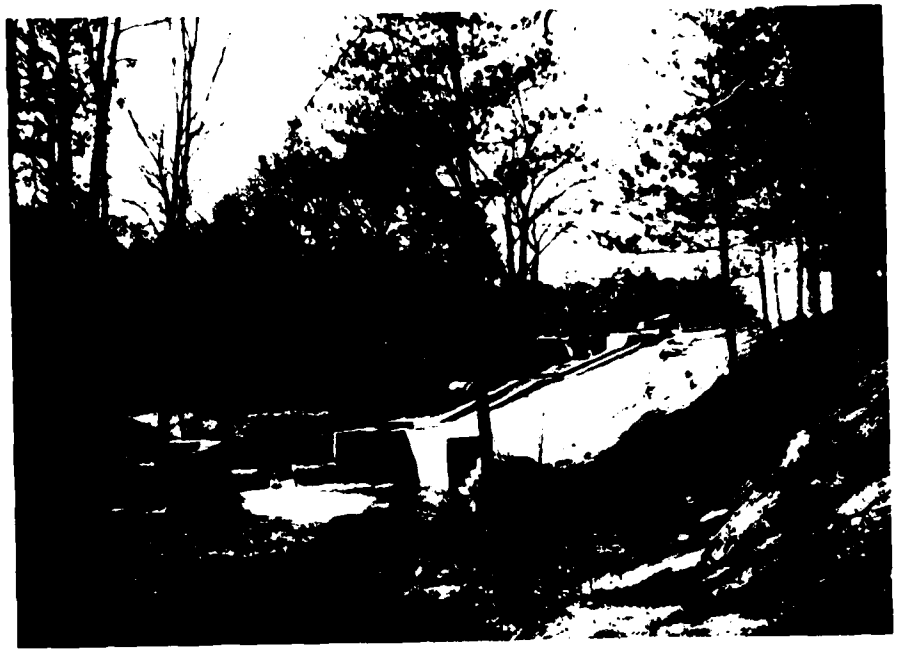


Photo # 11 Downstream Slope Tihonet Pond #1 Dam

U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM , MASSACHUSETTS ASEC CORP. CONSULTING ENGINEERS BOSTON , MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS	TIHONET POND NO.2 DAM TR. TO WANKINCO RIVER WAREHAM, MASS. MA 00030 DECEMBER 9, 1980

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

TIHONET POND NO. 2 DAM

WAREHAM, MA

Dam Rating Curve

A schematic sketch of the dam and outlet structures is shown in Figure 1. The sketch is based on a recent field inspection and survey of the site. This information was used in the hydrologic and hydraulic analysis of the dam.

North Outlet Spillway Discharge (left side)

$Q_1 = CLH^{1.5}$

C = 3.2 (sharp-crested weir)

L = 4.4'

H = head on weir crest (datem elev. 37.7 MSL)

$Q_1 = 3.2 \times 4.4 \times H^{1.5}$

North Outlet Spillway Discharge (right side)

$Q_2 = CLH^{1.5}$

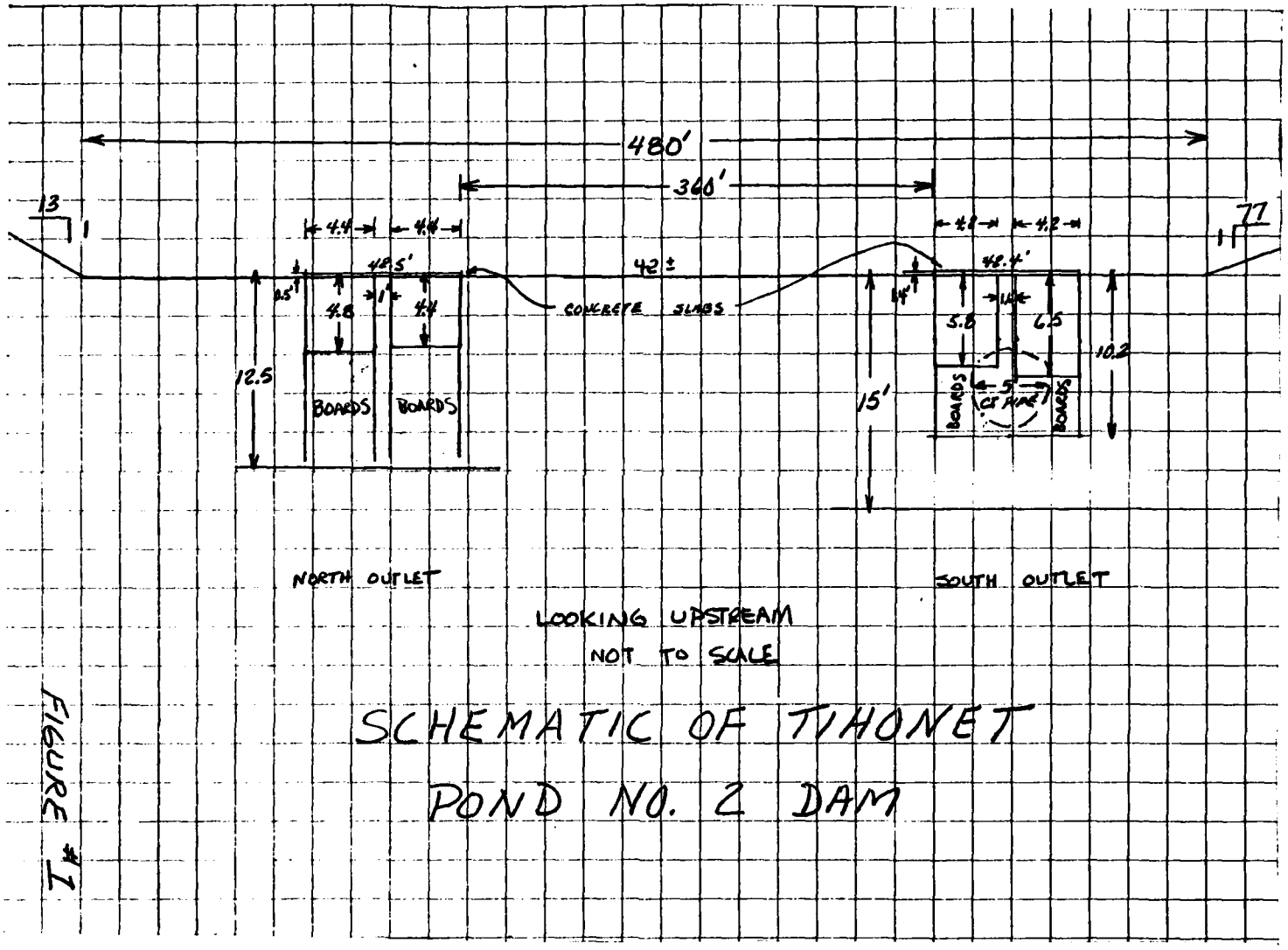
C = 3.2 (sharp-crested weir)

L = 4.4'

H = head on weir crest (datem elev. 38.1 MSL)

North Outlet Spillway Discharge (total)

$Q_{\text{north outlet spillways}} = Q_1 + Q_2$



SCHEMATIC OF TIHONET POND NO. 2 DAM

FIGURE #1

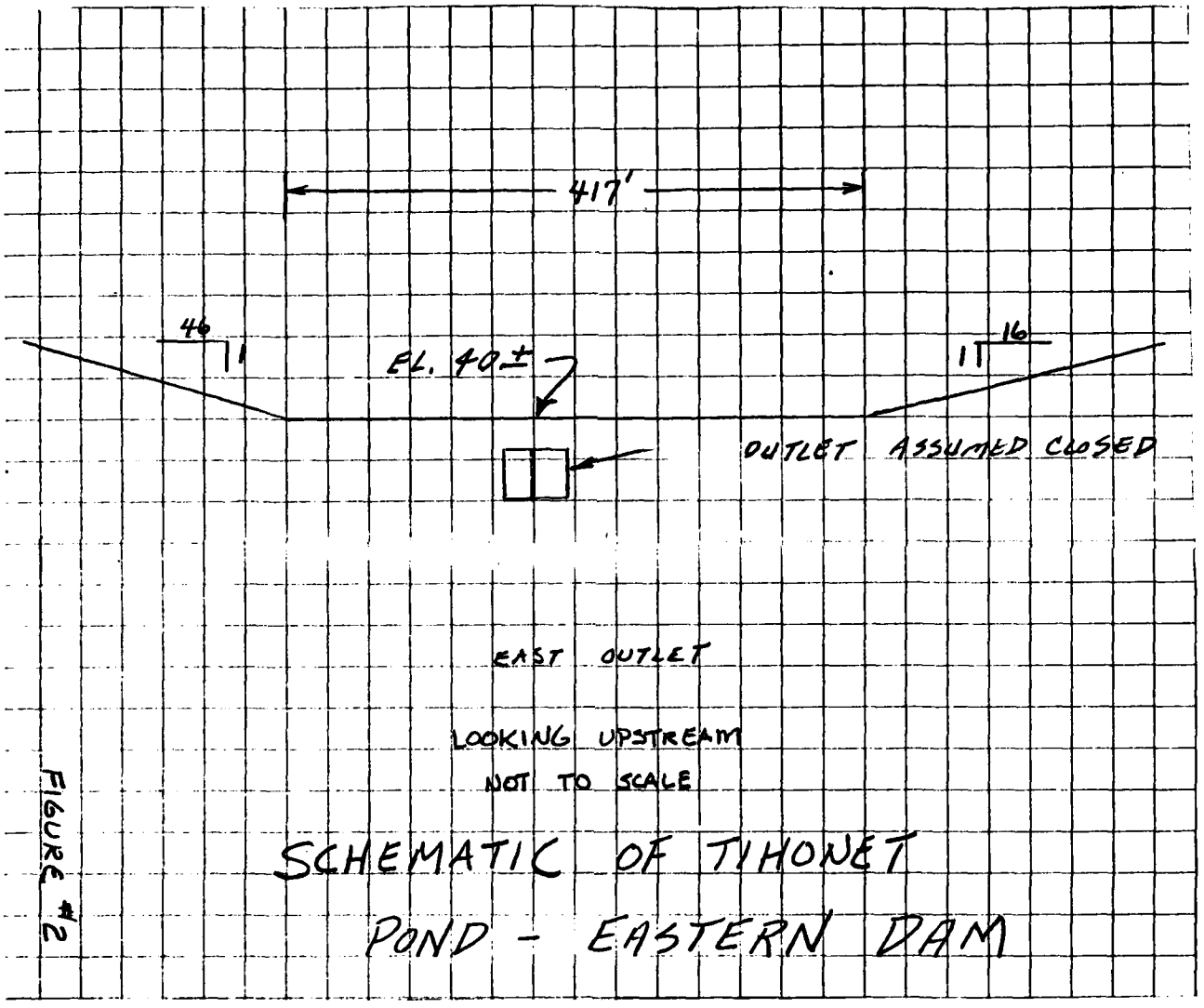


FIGURE #2

SCHEMATIC OF TIHONET POND - EASTERN DAM

The north outlet structure also contains two box culverts -4.2 x 3.7 and -4.2 x 3.5 below the north spillways shown in Figure 1. The top of box for these culverts is at 31' MSL. The capacity of these culverts was checked using the Bureau of Public Roads Hydraulic Charts assuming inlet control and found to be sufficient to handle all discharges passing over the north outlet spillways. Therefore, only the north outlet spillways are shown on Figure 1.

South Outlet Spillway Discharge (left side)

$Q_3 = CLH^{1.5}$

C = 3.2 (sharp-crested weir)

L = 4.2

H = head on weir crest (datem elev. 36.6 MSL)

$Q_3 = 3.2 \times 4.2 \times H^{1.5}$

South Outlet Spillway Discharge (right side)

$Q_4 = CLH\ 1.5$

C = 3.2 (sharp-crested weir)

L = 4.2

H = head on weir crest (datem elev. 35.9 MSL)

$Q_4 = 3.2 \times 4.2 \times H^{1.5}$

South Outlet Spillway Discharge (total)

$Q_{\text{south outlet spillways}} = Q_3 + Q_4$

Below the south outlet spillways is a 5' diameter cast iron pipe. The capacity of this pipe was checked using the Bureau of Public Roads Hydraulic Charts assuming a concrete pipe of comparable roughness coefficient and assuming inlet control. It was found that the 5' CI pipe would cause the spillways to be submerged and therefore would control the outflow through the south outlet. The effects of the submerged weir were assumed to be negligible and a composite stage-discharge curve was constructed for the south outlet (see Graph 2).

In addition to the north and south outlets, there is also an outlet on the southeast side of Tihonet Pond on Tihonet Road (Figure 2). This outlet was assumed to be closed but flow over the roadway is computed using the standard weir flow equations.

Dam Embankment Overflow Discharge - East Outlet

$Q_5 = CLH^{1.5}$

$C = 2.6$ (broad-crested weir)

$L = 417'$

H = head on weir crest (datem elev. 40' MSL)

$Q_5 = 2.6 \times 417 \times H^{1.5}$

Dam Embankment Side-Slope Discharge - Left

$Q_6 = CLH^{1.5}$

$C = 2.6$ (broad-crested weir)

$L = 46 \times H$

$h = 0.5 \times H$

$Q_6 = 2.6 \times (46 \times H) \times (0.5 \times H)^{1.5}$

Dam Embankment Side-Slope Discharge - Right

$$Q_7 = CLH^{1.5}$$

$C = 2.6$ (broad-crested weir)

$L = 16 \times H$

$h = 0.5 \times H$

$$Q_7 = 2.6 \times (16 \times H) \times (0.5 \times H)^{1.5}$$

Total Dam Discharge

$$Q_{Total} = Q_{\substack{North \\ Outlet \\ Spillways}} + Q_{\substack{South \\ Outlet \\ Composite}} + Q_5 + Q_6 + Q_7$$

The above relationship is plotted as the stage discharge curve for Tihonet Pond No. 2 (Graph 1).

DAM FAILURE ANALYSIS

Dam Failure with Maximum Pool

Assume that the dam fails with the pool at maximum level, which corresponds to the elevation of the top of the embankment (42.0 FEET MSL). The enclosed south outlet control structure includes two small flashboard dams followed by a 5' diameter cast iron pipe. The top of the embankment is 5.4' above the left spillway crest and 6.1' above the right spillway crest (looking downstream). The embankment is also 9.2' above the invert at the pipe entrance and 15.0' above the downstream invert (below the pipe).

Normal Outflow at Failure

Q = 234 CFS (dam rating with H = 9.2') *

*NOTE: Assume that only south outlet contributes to downstream flows because north outlet and east outlet have their own channels and follow different flow paths.

Tailwater Level at Failure

Cross-sections located throughout the downstream impact area were coded and input into a HEC-2 multiple profile run using nine discharges covering the range of discharges expected during dam failure analysis. Results were used to construct stage-discharge and stage-cross-section area curves for each cross section (see Graphs 2- 7).

The following are locations of cross-sections used in the dam failure analysis:

Distance D/S of Dam (FT)	Normal Water Level (FT MSL)
105	16.0
422	15.0
615	14.2
1675	14.0
2629	14.0

Immediately preceding failure, the normal outflow of 234 CFS results in a depth of 3.0 FEET (Graph 3) at the section located 105' downstream of the spillway.

Breach Outflow

$$Qp_1 = 8/27 \times Wb \times \sqrt{g} \times Y_o^{1.5}$$

where: Wb = width of breach
$\leq$ 0.4 X (width of dam at ½ height)
$\leq$ 0.4 X 480'

use: Wb = 192'

Y_o = pool elevation - downstream invert = 15.0'

$$Qp_1 = 8/27 \times 192 \sqrt{g} \times 15.0^{1.5} = 18{,}754 \text{ CFS}$$

Total Outflow

Q_{total} = 234 + 18,754 = 18,988 CFS

The table below gives pre-failure,downstream stages resulting from entering each section's stage-discharge curve at a discharge of 234 CFS (normal outflow at failure).

Section (FT D/S of dam)	Pre-Failure Stage (FT MSL)
105	17.5
422	16.4
615	14.5
1675	14.5
2629	14.5

Impounding Capacities of Reservoir

Pool at top of dam (maximum - 42.0' MSL)
Volume = 1235 ACRE-FT

Pool at normal storage capacity (COE inventory)
Volume = 540 ACRE-FT

Downstream Flooding

At 105' downstream of dam

Prior to failure

depth = 3.0' (Graph 3, with Q = 234 CFS)

After failure

depth = 20.8' (Graph 3, with Q = 18,988 CFS)

Reach from 105' downstream to 422' downstream of dam

To estimate peak dam break flow at a distance 422' feet downstream of dam, we followed (essentially) the COE "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs."

Use stage-discharge and stage-cross-section area curves for sections 105' and 422' downstream of dam (Graphs 3 and 4).

Storage volume in reach-versus-outflow

Assume channel and overbank storage of the flood wave is equal to the reach length times the average of the upstream post-failure flow area minus the upstream pre-failure flow area and the downstream post-failure flow area minus the downstream pre-failure flow area:

$$\text{Volume } (Ft^3) = \left[\frac{(Ap_1 - A_{N_1}) + (Ap_1 - A_{N_2})}{2} \right] \times L$$

where : Ap_1 = post-failure u/s cross-sectional flow area (Ft^2)

A_{N_1} = pre-failure u/s cross-sectional flow area (Ft^2)

A_{p_2} = post-failure d/s cross-sectional flow area (Ft^2)

A_{N_2} = pre-failure d/s cross-sectional flow area (Ft^2)

L = reach length in feet

The attenuation of dam failure flow due to storage in the reach between 105' and 422' d/s:

$$Q_2 = 234 + Q_{p_1}\left(1 - \frac{V_1}{S}\right) = 234 + 18{,}754\left(1 - \frac{V_1}{1235}\right)$$

where: V_1 = volume of storage in reach, above pre-failure stage (acre-feet)

S = storage in reservoir before failure (acre-feet)

Q_{p_1} = *breach outflow at upstream end of reach*

Q_2 = total outflow at downstream end of reach after dam failure

The attenuation of peak dam failure flow at the downstream end of this reach is calculated on Graph 4. It can be seen from Graph 4 that the attenuation in the first reach has a negligible effect on discharge at the downstream end ot the reach (section 2207). The attenuated peak failure flow at 422' d/s of the dam is 18,270 CFS with a corresponding stage of 29.0'. This post-failure stage is 12.6' above pre-failure stage and 14.0' above normal stream level.

There are three mill buildings located in the first reach (approximately 105' to 422' d/s). Their elevations range 4'-12' above stream level and these buildings would receive major damange. If occupied at the time of failure, there is also a significant danger of loss of life. Hammond Street runs just to the west of Tihonet Pond crossing the stream from the north outlet. The roadway embankment would be subject to overtopping by the flood wave along with probable washout just north of the intersection of Tihonet Road and Hammond Street. There is one house just south of the stream from the

north outlet on Hammond Street and this would suffer major damage. There is also a significant danger of loss of life at this location. Cranberry bogs in the vicinity would also suffer damage.

Between 422' and 615' d/s of the dam, the peak failure flow is attenuated to 17,984 CFS (Graph #5). The stage, however, drops from 29.0' MSL at 422' to 24,3' MSL at 615' d/s of the dam. At about 520' d/s of the dam, Tihonet Road crosses the stream from the south outlet with two 5' diameter corrugated metal pipes providing for the waterway. This is subject to overtopping and wash-out by the flood wave. At about 615' d/s of the dam, an access road enters to the pump station on Tihonet Road. This pump station would receive major flood damage. One house is also located on the east bank of the stream from the south outlet about 615' d/s of the dam. This house would not experience any flooding.

Between 615' and 1675' d/s of the dam, the floodplain widens out as the stream flows through Maple Spamp. The attenuation of the peak failure discharge in this reach is calculated on Graph 6. The effects of the storage in Maple Swamp are beginning to reduce the discharge from 17,984 at 615' to 15,073 at 1,675' d/s of the dam in this reach. Assuming a linear peak failure profile from 24.3' at the upstream end to 21.8' at the downstream end of this reach, the dam failure would cause some damage to (probable) three commercial/industrial buildings. There is also some danger of loss of life at this location.

The peak failure flow is attenuated to 11,266 CFS at 2,629 d/s of the dam by Maple Swamp with a corresponding stage of 20.5' MSL (Graph 7). There are no structures near the floodplain in this vicinity. State Route 25, however, does cross Maple Swamp about

2,835 d/s of the dam and would be subject to erosional damage caused by the flood wave impacting the roadway and passing through the waterway openings. It is doubtful that the flood wave would cause the failure of the Route 25 embankment.

Parker Mills Pond is located just downstream of Maple Swamp. The extensive storage of the pond will quickly attenuate peak failure discharges and corresponding stages to insignificant levels. However, if the surcharge storage of Parker Mills Pond is unavailable then the volume of the peak failure discharge may contribute to a failure of Parker Mills Pond Dam. For a more detailed discussion of Parker Mills Pond Dam, refer to the Phase I - COE Dam Inspection Report for Parker Mills Pond Dam.

Test Flood Analysis

Size Classification: INTERMEDIATE (storage greater than 1000 and less than 50,000 acre-feet; height 40').

Hazard Classification: HIGH (based on significant danger of loss of life and significant economic loss at 3 mill buildings, 3 (probable) commercial/industrial buildings, 1 house, the Tihonet Road Pump Station, Hammond Street and Tihonet Road.

According to COE "Recommended Guidelines" the size and hazard classifications of the dam indicate a test flood equal to a PMF.

The COE PMF curves yield a discharge of 750 CFS/sq. mile for the flat and coastal region. This is a PMF of 6075 CFS for the 8.1 square mile drainage area.

Stage Storage Curve

The storage at the lowest spillway crest (35.9' MSL) is approximately 540 acre-feet. The pond surface area at 35.9' MSL is approximately 94 acres as measured from the USGS quadrangle map. The pond surface area at 40' MSL, the east outlet roadway crest, is approximately 121 acres as measured from the USGS quadrangle map. The storage is computed as follows:

$$\text{Surcharge Storage} = \left[\frac{94 + 121}{2} \times h\right] = 108 \times 4.1$$

$$= 443 \text{ acre feet}$$

$$\text{Total Storage} = 540 + 443 = 983 \text{ acre feet.}$$

The stage storage curve is given on Graph #8.

For the drainage area of 8.1 square miles or 5,184 acres:

$$1\text{" of runoff} = \frac{5{,}184\ (1")}{12"/\text{foot}} = 432 \text{ acre-feet}$$

1 acre-foot = 1/432 = 0.0023" of runoff

Surcharge Storage to the roadway crest =

443 acre-feet = 1.0" of runoff

The attenuation of the test flood inflow due to surcharge storage in the pond is calculated on Graph 9.

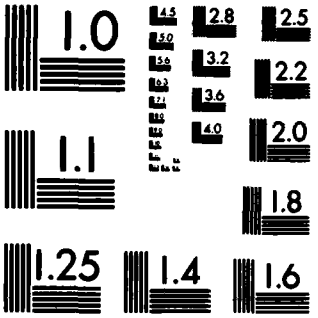
The peak test flood outflow is 5500 CFS, with a corresponding stage of 42.45 MSL, which is 2.5' above the top of the roadway crest at the east outlet and 0.5' above the dam crest at the south outlet.

The table below summarizes the downstream effect of failure of Tihonet Pond Dam No. 2:

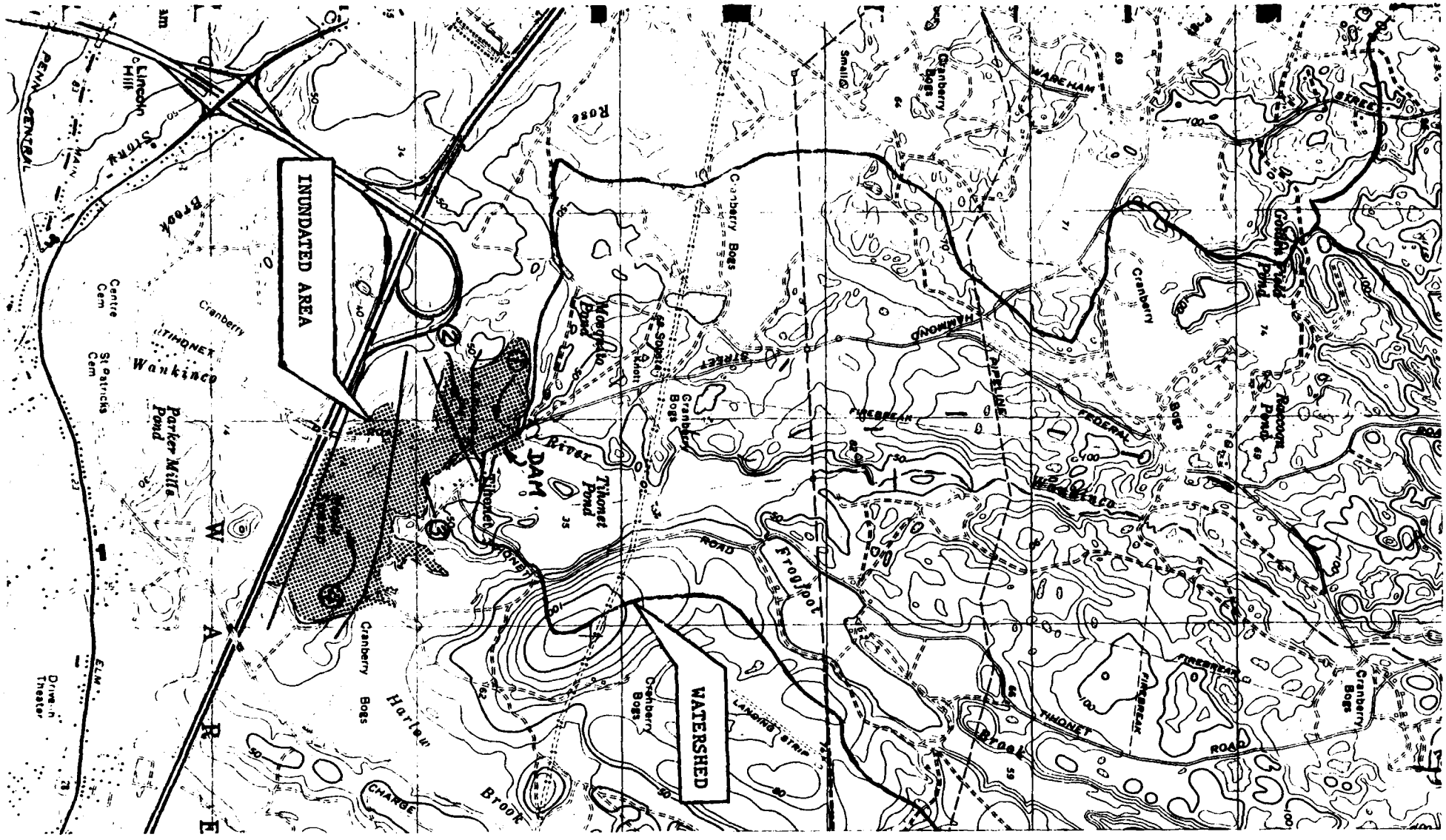
Location no. (see map)	Distance D/S of Dam (ft)	Number of Structures	Level Above Stream (ft)	Flow (CFS) Stage (Ft. above Stream) Before Failure	After Failure	Comments
1	105 - 422	3 mill buildings	4-12	234/1.5	18,988/19.3	Major damage to mill buildings. Significant danger of loss of life.
		road	4-5			Probable wash-out.
		1 house	4-5			Major damage to 1 house. Significant danger of loss of life.
2	422-615	road	5	234/1.4	18,270/14	Probable wash-out.
	615	pump station	5-6			Major damage to pump sta.
		1 house	15-16			
3	615-1,675'	3(probable) commercial/ industrial bldgs.	5-10	234/0.3	17,984/10.2	Some damage to (probable) commercial/industrial buildings. Some danger of loss of life.
4	1,700			234/0.5	15,073/7.8	Flood wave attenuating in Maple Swamp.
	2,629			234/0.5	11,266/6.5	
	2,835	road	15-26			Some erosional damage as flood wave impacts roadway & passes through waterway openings.

AD-A145 342 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
TIHONET POND NUMBER 2.. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV JUL 81

UNCLASSIFIED F/G 13/13 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



WATERSHED PLAN/CROSS-SECTION LOCATIONS

TIHONET POND NO. 2 DAM

WAREHAM, MASSACHUSETTS

1" = 2,083.3'

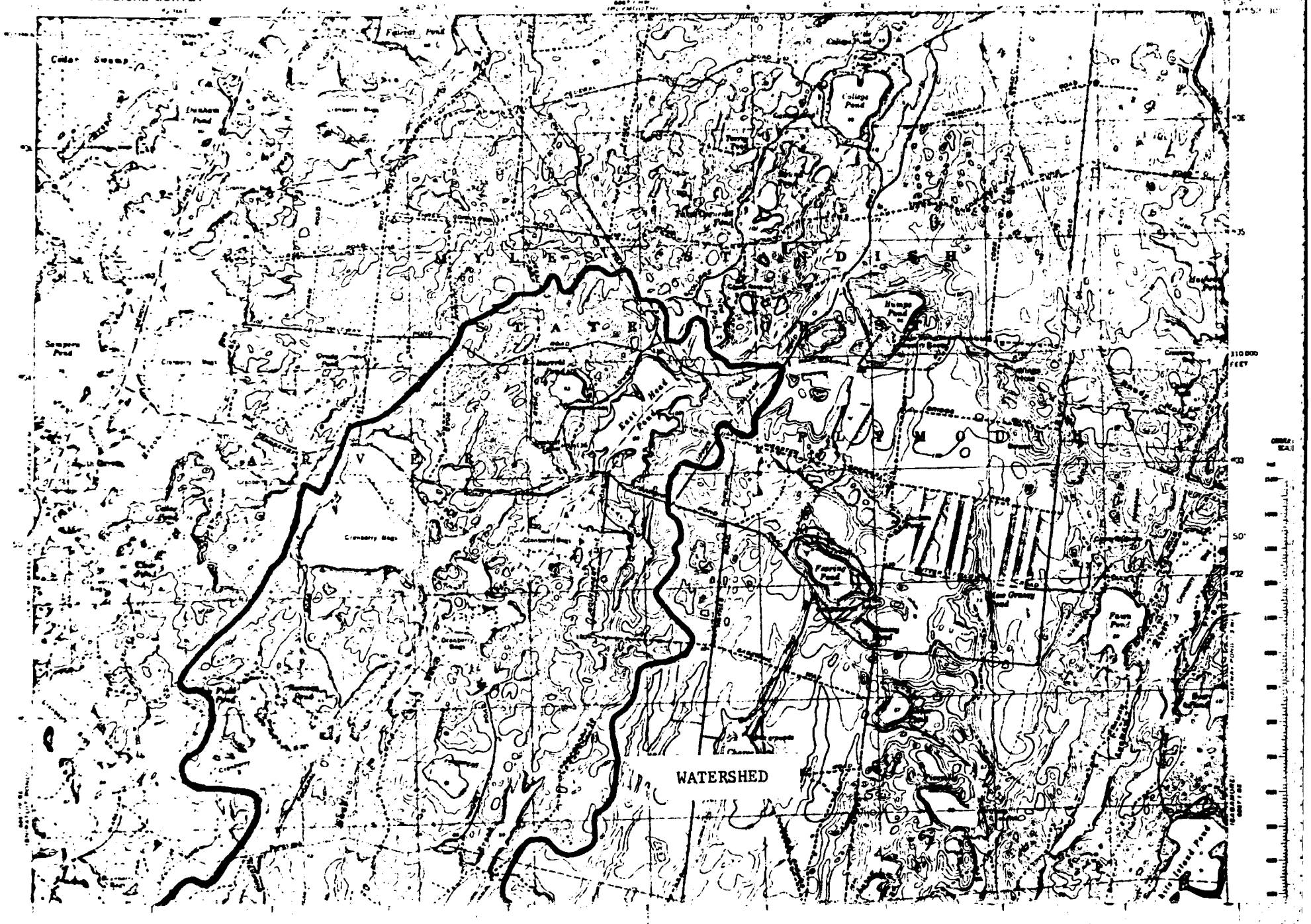
ASEC CORPORATION

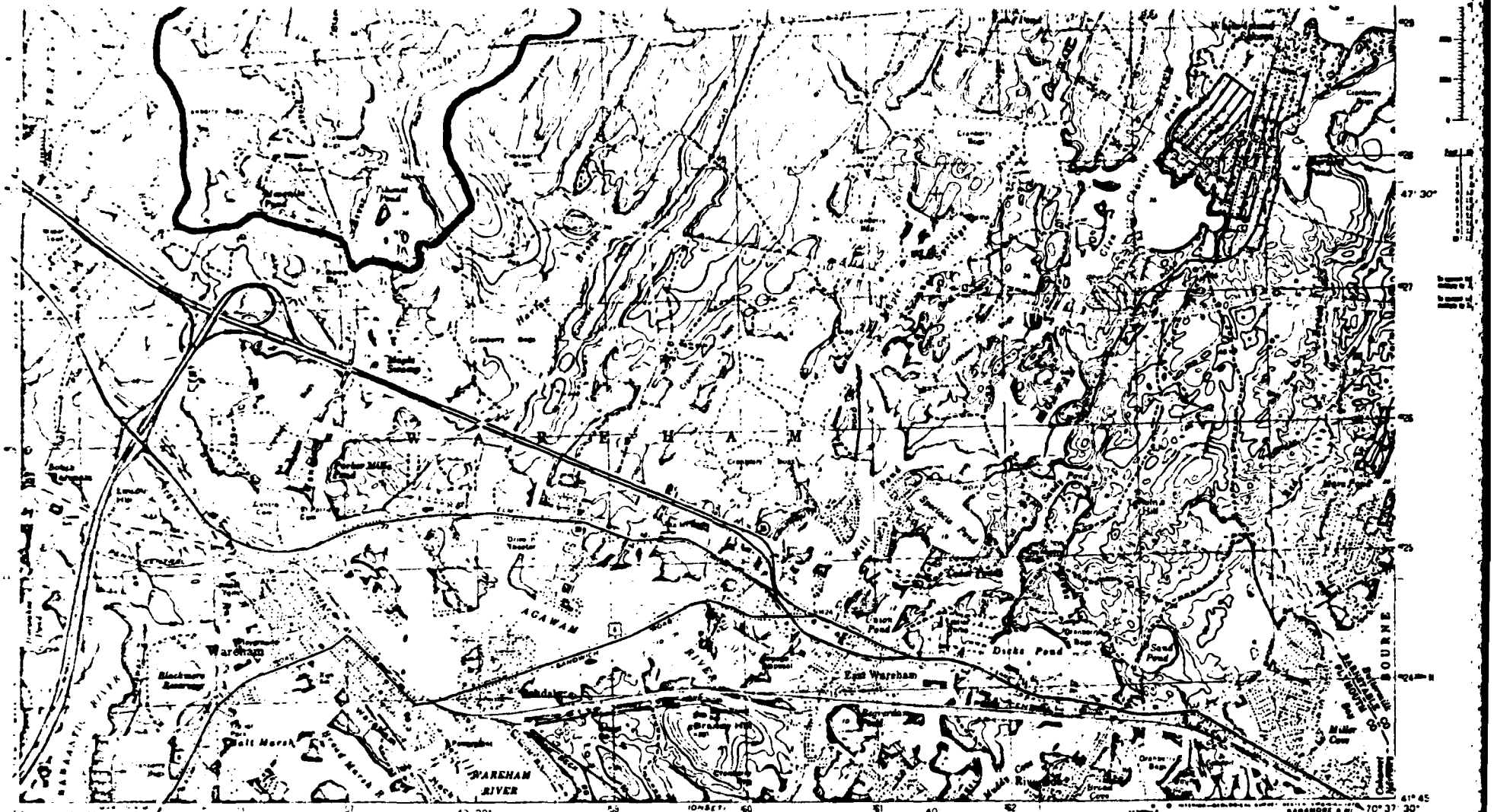
WAREHAM QUADRANGLE

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS

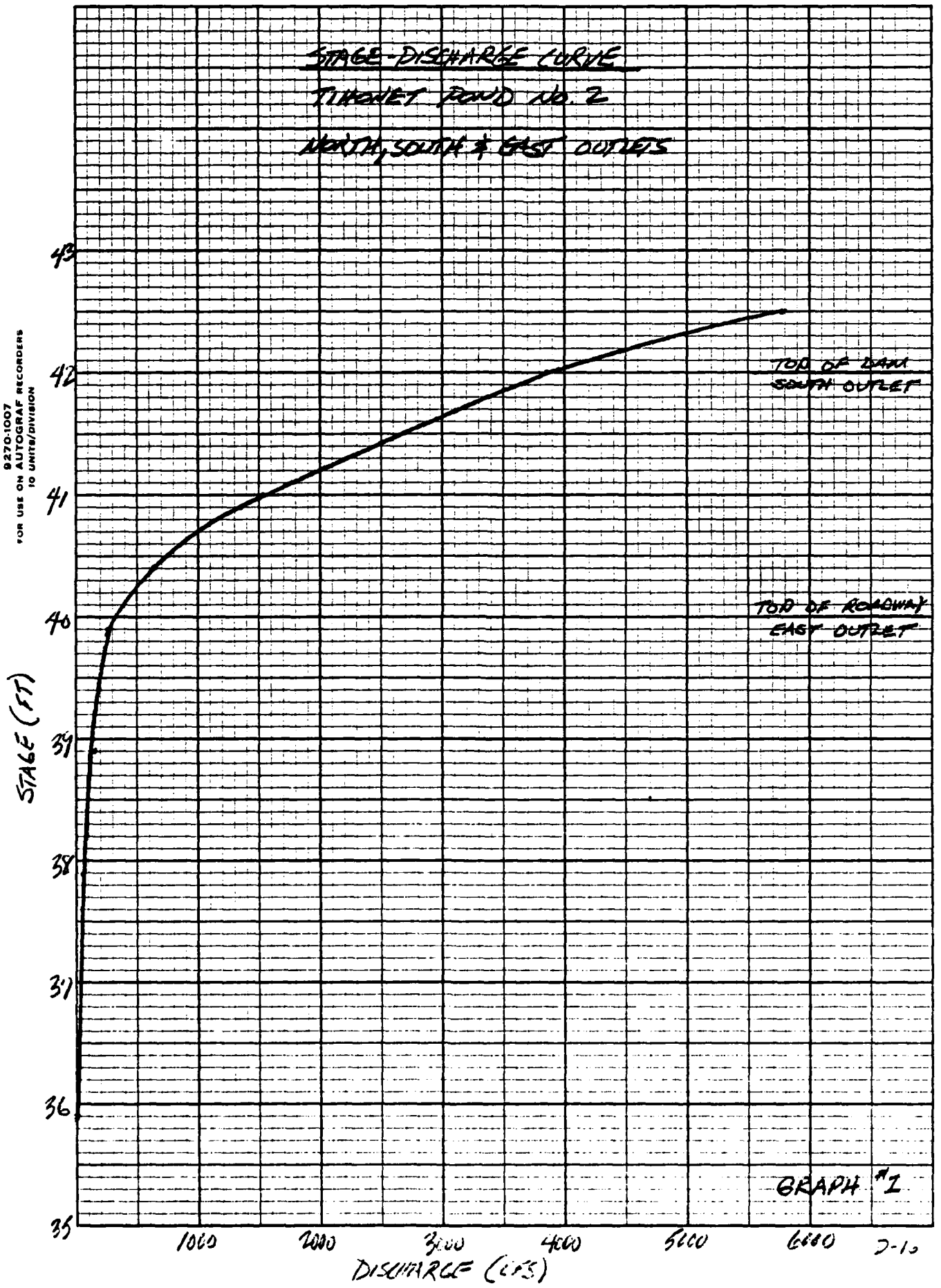
WAREHAM QUADRANGLE
MASSACHUSETTS
7.5 MINUTE SERIES (TOPOGRAPHIC)

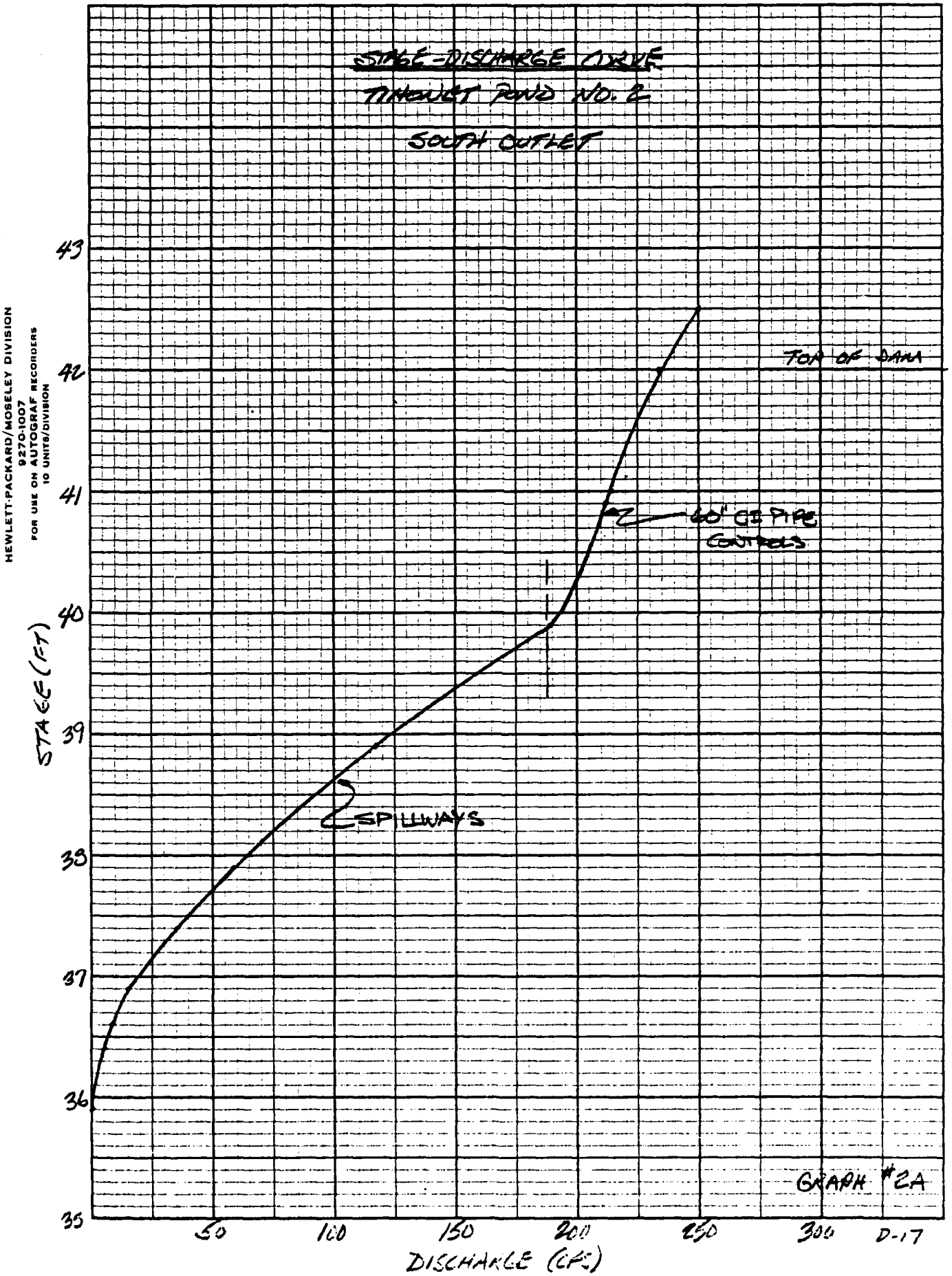


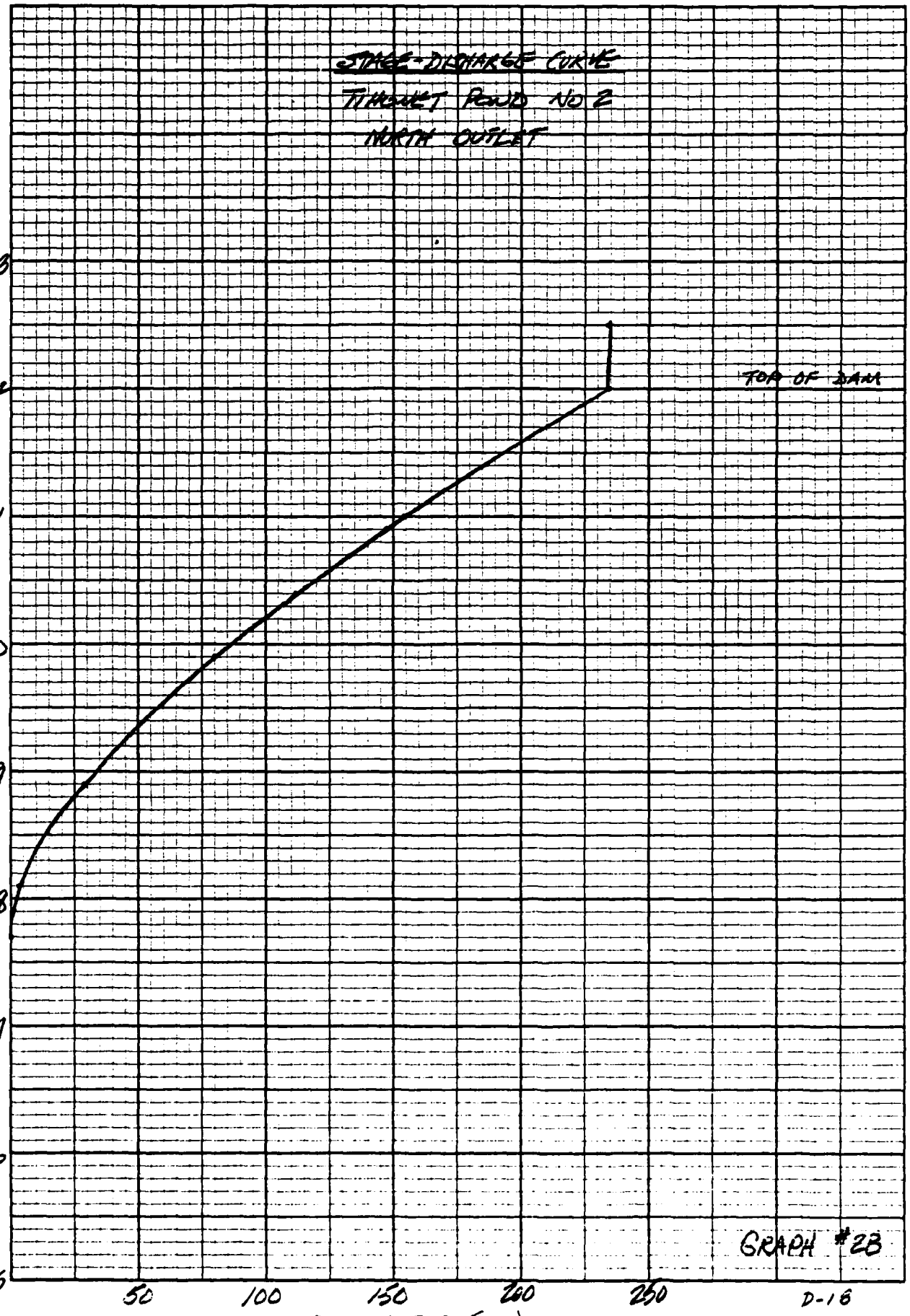


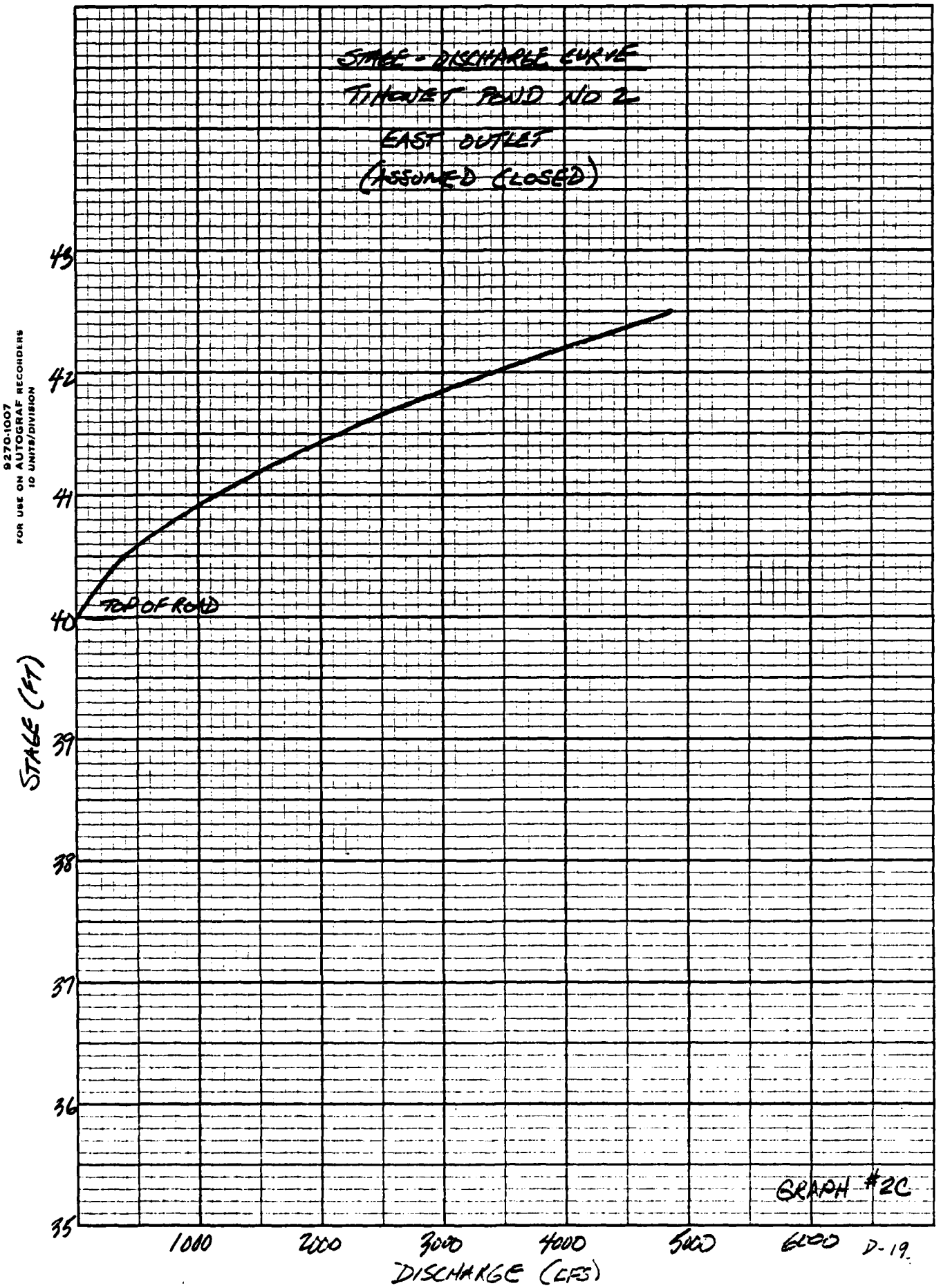
WATERSHED PLAN - TIHONET POND NO. 2 DAM

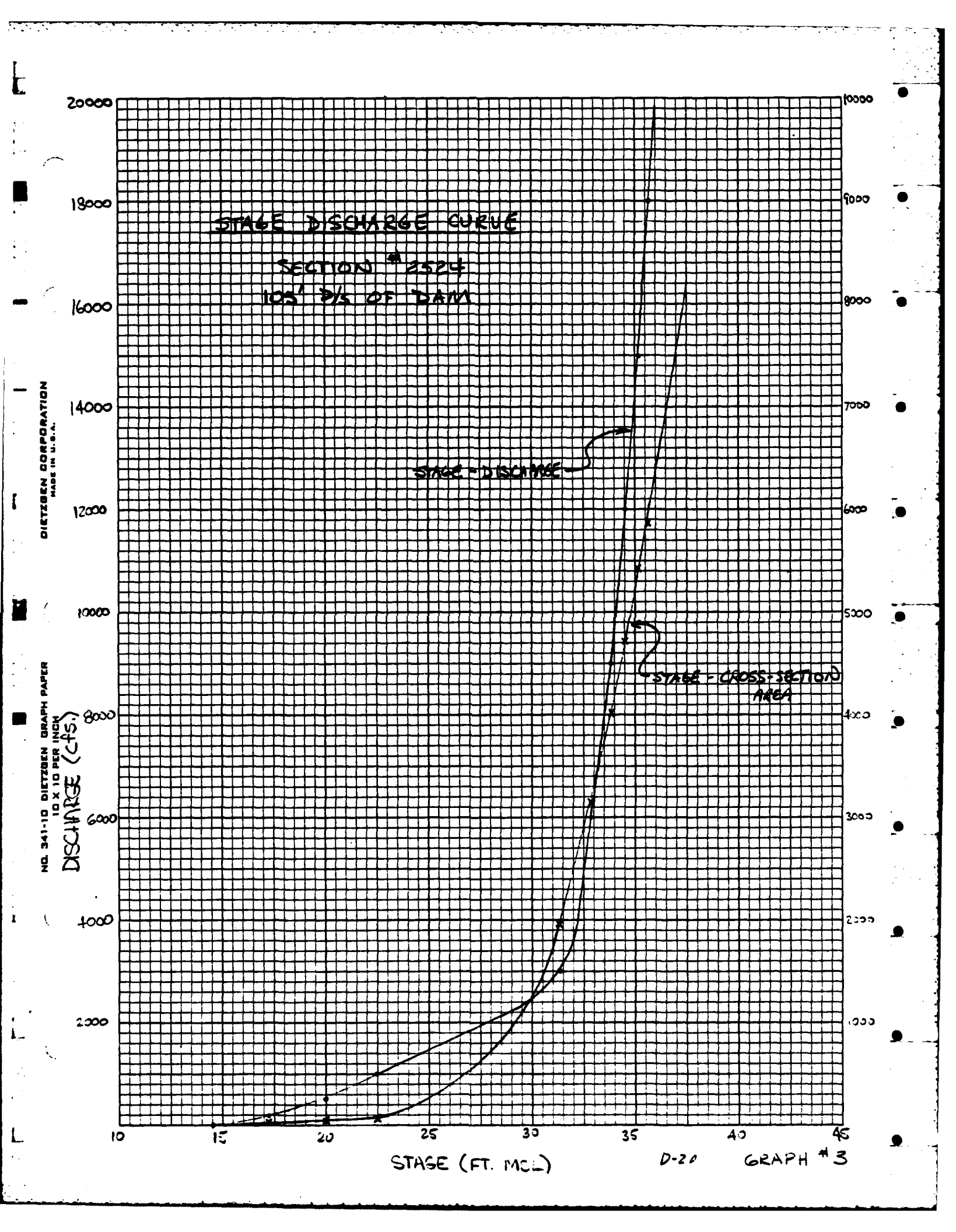
D-15A

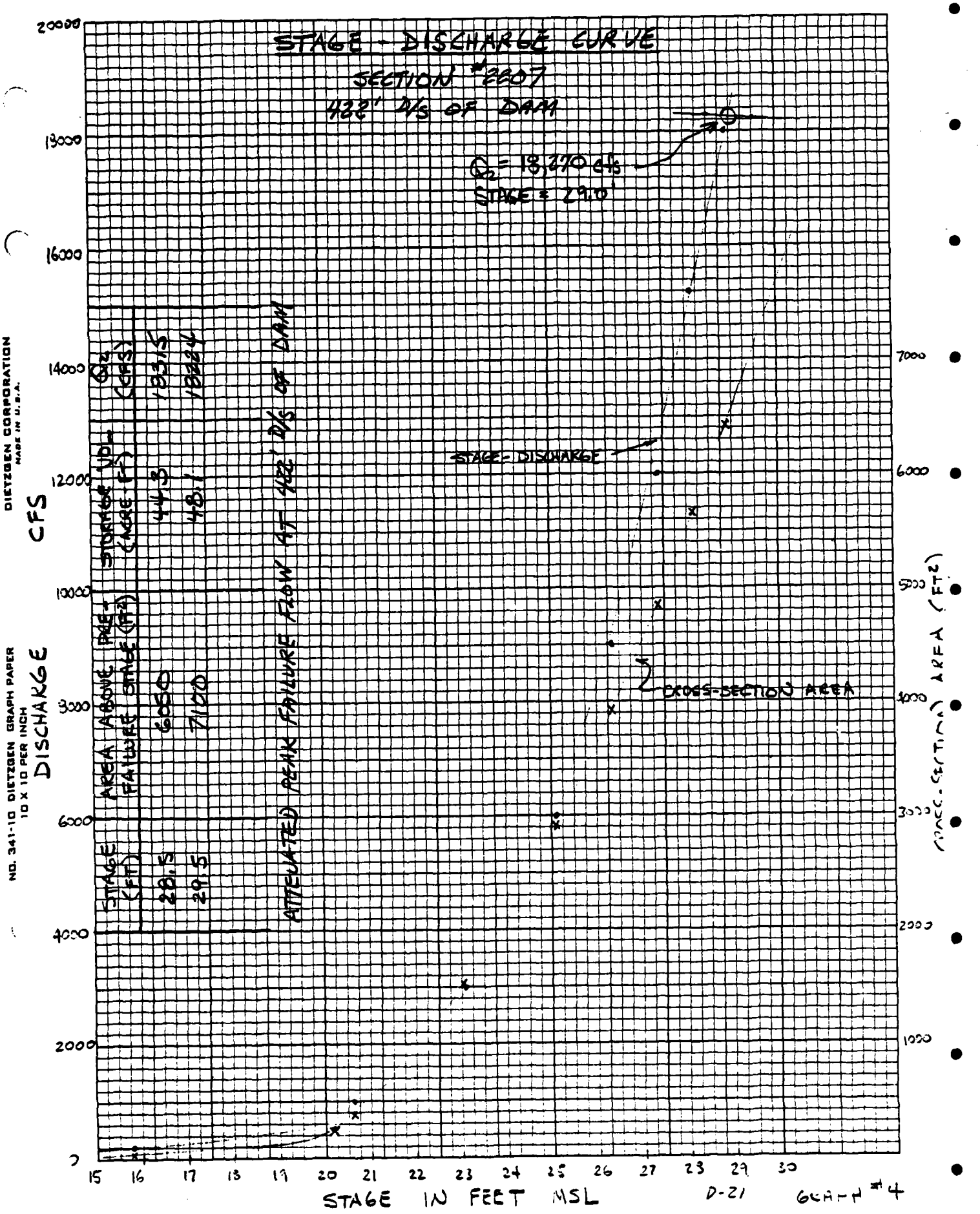

STAGE-DISCHARGE CURVE
TURNER POND NO. 2
NORTH, SOUTH & EAST OUTLETS
TOP OF DAM SOUTH OUTLET
TOP OF ROADWAY EAST OUTLET
GRAPH #1
STAGE (FT)
DISCHARGE (CFS)
43
42
41
40
39
38
37
36
35
1000
2000
3000
4000
5000
6000
HEWLETT-PACKARD/MOSELEY DIVISION
9270-1007
FOR USE ON AUTOGRAF RECORDERS
10 UNITS/DIVISION


STAGE-DISCHARGE CURVE
TIMBERLET POND NO. 2
SOUTH OUTLET
HEWLETT-PACKARD/MOSELEY DIVISION
9270-1007
FOR USE ON AUTOGRAF RECORDERS
10 UNITS/DIVISION
STAGE (FT)
43
42
41
40
39
38
37
36
35
TOP OF DAM
60" CS PIPE CONTROLS
2 SPILLWAYS
50
100
150
200
250
300
DISCHARGE (CFS)
GRAPH #2A
D-17

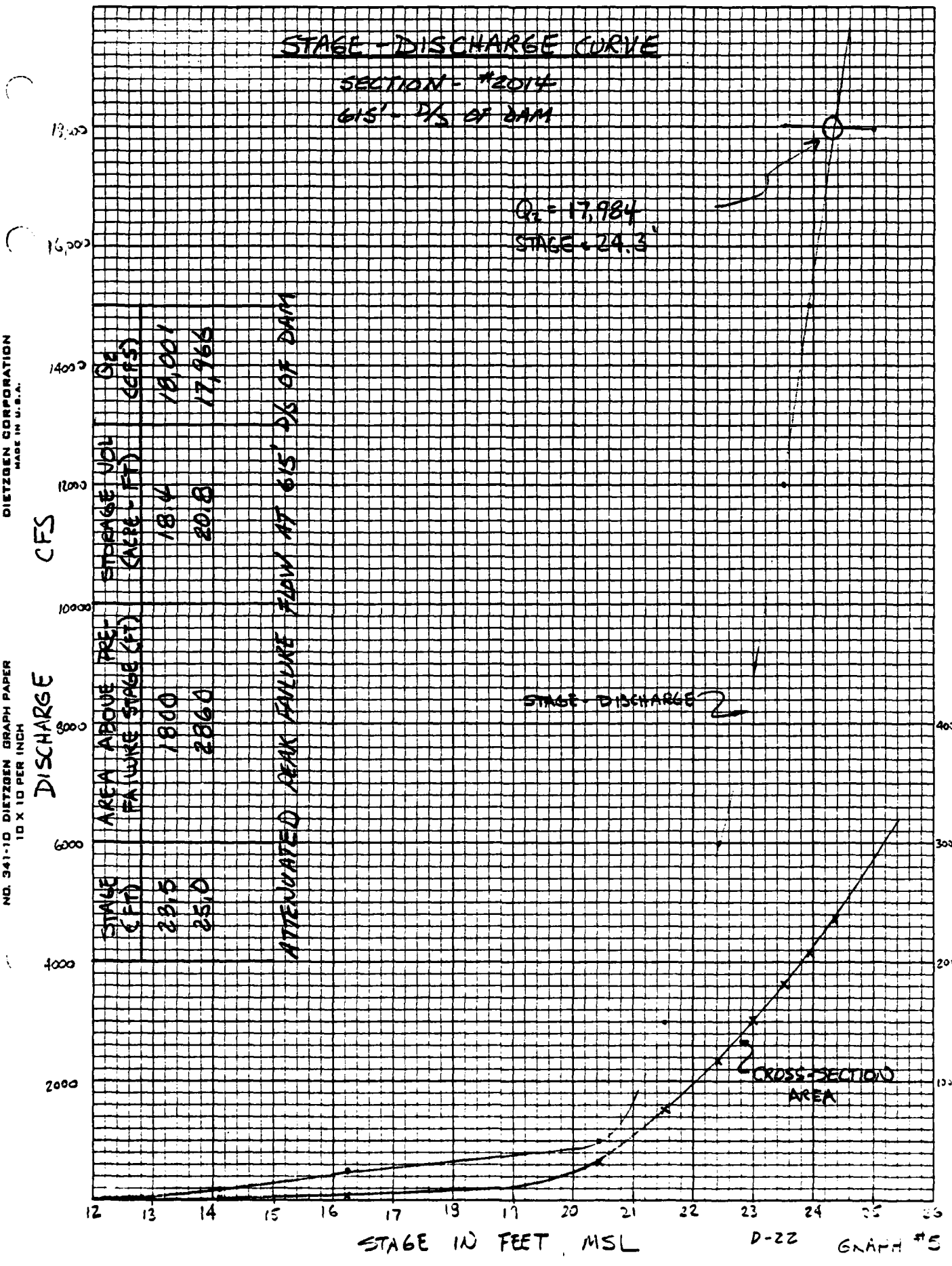

STAGE-DISCHARGE CURVE
TIMBLET POND NO 2
NORTH OUTLET
TOP OF DAM
43
42
41
40
39
38
37
36
35
STAGE (FT)
50
100
150
200
250
DISCHARGE (CFS)
GRAPH #2B
D-16
HEWLETT-PACKARD/MOSELEY DIVISION
9270-1007
FOR USE ON AUTOGRAF RECORDERS
10 UNITS/DIVISION

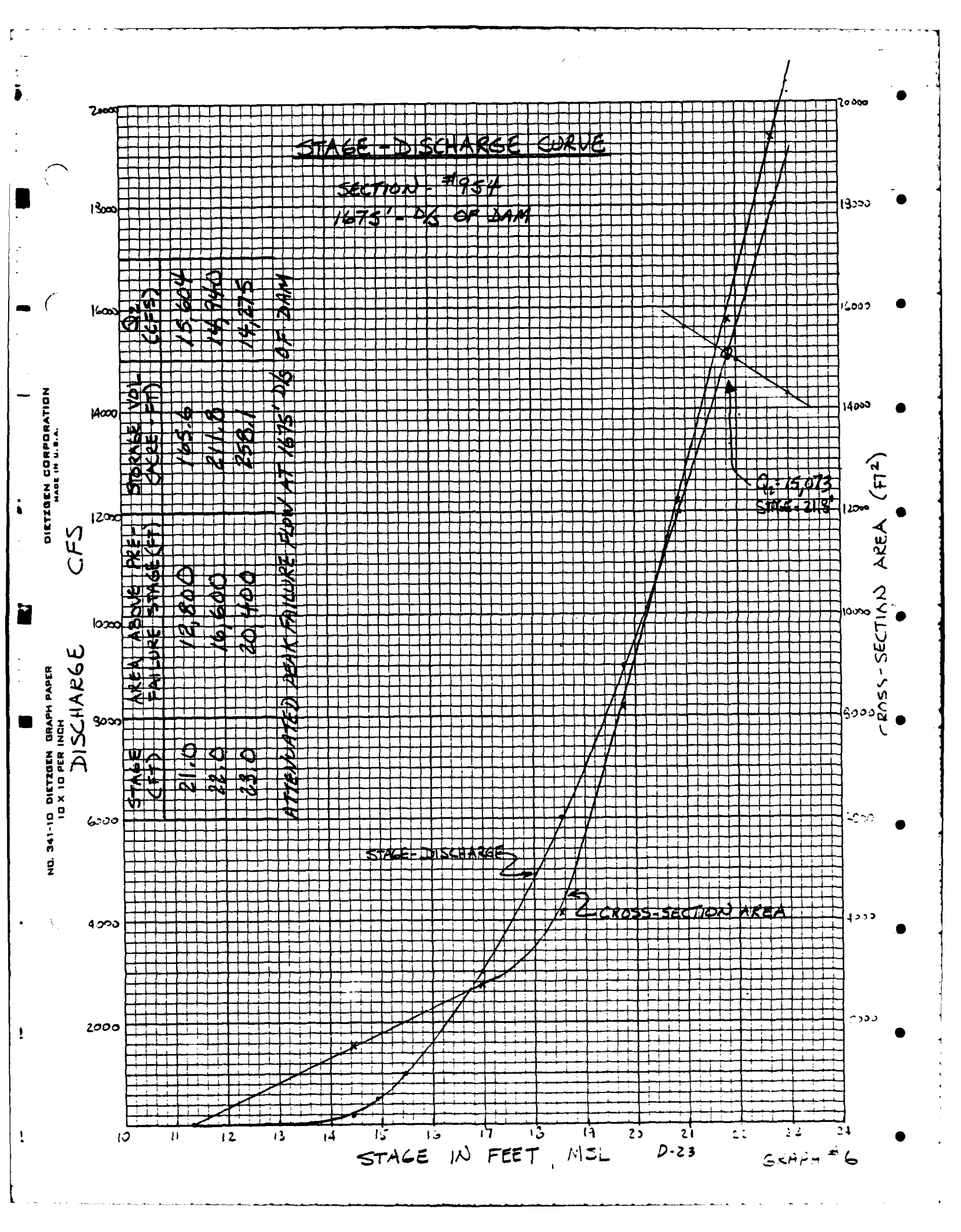

STAGE - DISCHARGE CURVE
TIMBER POND NO 2.
EAST OUTLET
(ASSUMED CLOSED)
TOP OF ROAD
STAGE (FT)
43
42
41
40
39
38
37
36
35
1000
2000
3000
4000
5000
6000
DISCHARGE (CFS)
GRAPH #2C
HEWLETT-PACKARD/MOSELEY DIVISION
9270-1007
FOR USE ON AUTOGRAF RECORDERS
10 UNITS/DIVISION

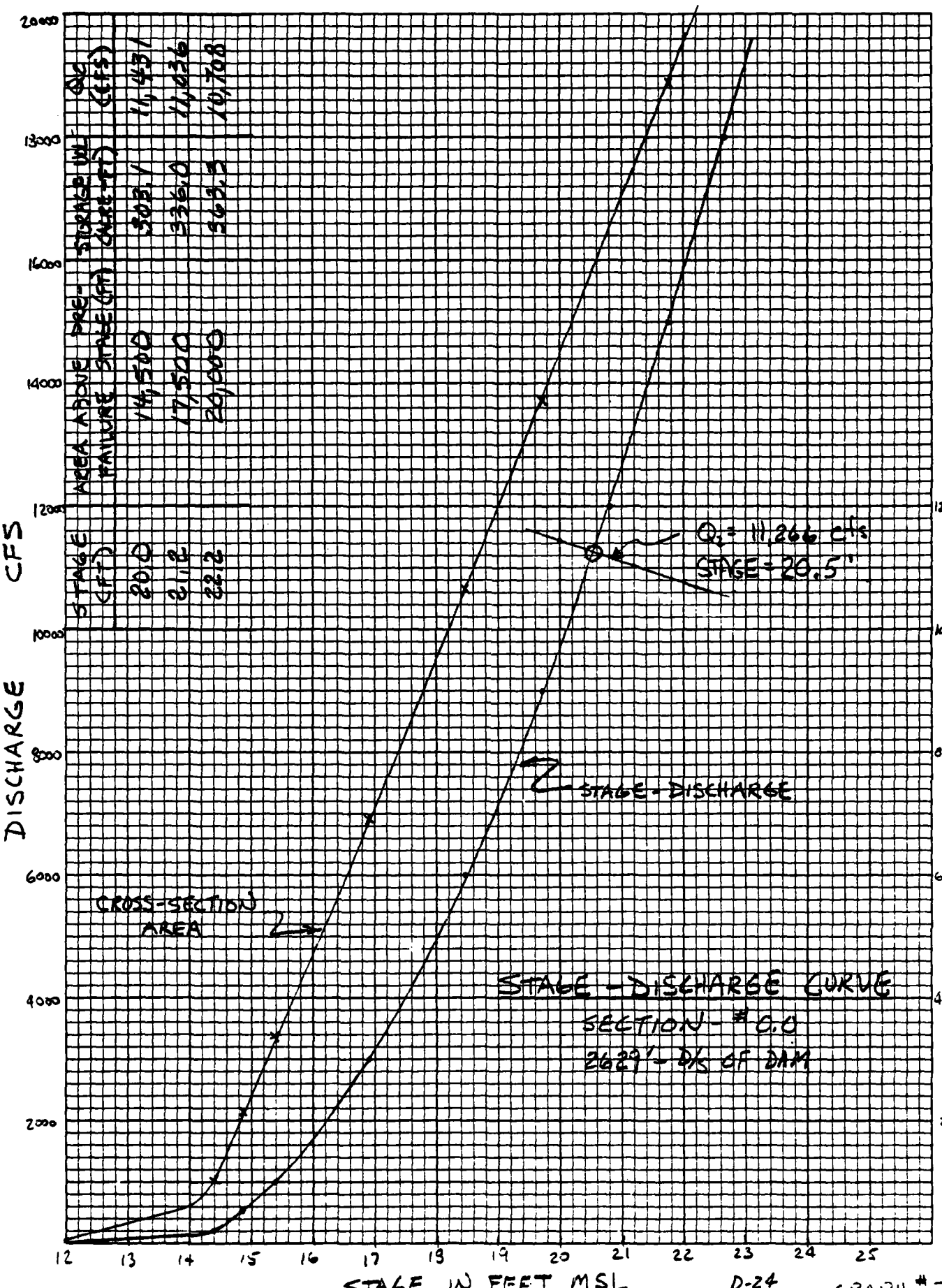

STAGE DISCHARGE CURVE
SECTION # 2524
105' D/S OF DAM
STAGE - DISCHARGE
STAGE - CROSS-SECTION AREA
DISCHARGE (cfs)
STAGE (FT. MSL)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
10
15
20
25
30
35
40
45
DIETZGEN CORPORATION MADE IN U.S.A.
NO. 341-10 DIETZGEN GRAPH PAPER 10 X 10 PER INCH
D-20
GRAPH # 3

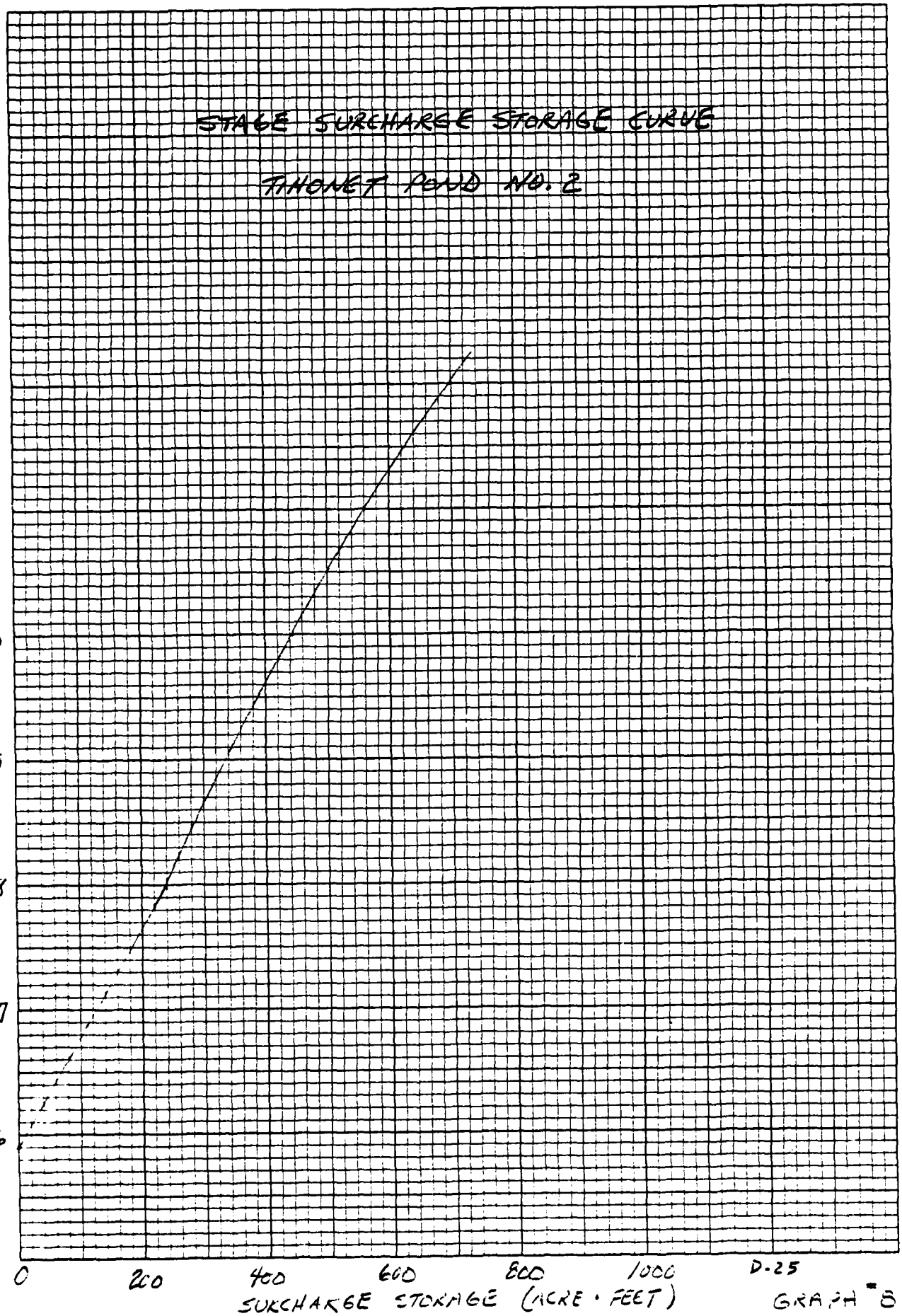

STAGE - DISCHARGE CURVE
SECTION #2607
1122' D/S OF DAM
Q_2 = 18,270 cfs
STAGE = 29.0'
STAGE-DISCHARGE
CROSS-SECTION AREA
ATTENUATED PEAK FAILURE FLOW AT 1122' D/S OF DAM
STAGE (FT)
AREA ABOVE PMS + FAILURE STAGE (FT²)
STORAGE ABOVE PMS + FAILURE STAGE (ACRE FT)
Q_2 (CFS)
28.5
6050
443
18315
29.5
7120
481
18224
DISCHARGE
CFS
STAGE IN FEET MSL
CROSS-SECTIONAL AREA (FT²)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
7000
6000
5000
4000
3000
2000
1000
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
DIETZGEN CORPORATION
MADE IN U.S.A.
NO. 341-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

D-21 GRAPH #4


STAGE - DISCHARGE CURVE
SECTION - #2014
615' - D/S OF DAM
Q_2 = 17,984
STAGE = 24.3'
ATTENUATED PEAK FAILURE FLOW AT 615' D/S OF DAM
STAGE - DISCHARGE
CROSS-SECTION AREA
DISCHARGE CFS
STAGE IN FEET MSL
CROSS-SECTIONAL AREA (FT²)
STAGE (FT) | AREA ABOVE PRE-FAILURE STAGE (FT²) | STORAGE VOL (ACRE-FT) | Q_2 (CFS)
23.5 | 1800 | 18.4 | 18,001
25.0 | 2360 | 20.8 | 17,965
DIETZGEN CORPORATION MADE IN U.S.A.
NO. 341-10 DIETZGEN GRAPH PAPER 10 X 10 PER INCH


STAGE - DISCHARGE CURVE
SECTION - #954
1675' - D/S OF DAM
DISCHARGE CFS
CROSS-SECTION AREA (FT²)
STAGE IN FEET, MSL
STAGE-DISCHARGE
CROSS-SECTION AREA
Q = 15,073
STAGE = 21.8'
ATTENUATED PEAK FAILURE FLOW AT 1675' D/S OF DAM
STAGE (FT) | AREA ABOVE PRE-FAILURE STAGE (FT²) | STORAGE VOL. (ACRE-FT) | Q (CFS)
21.0 | 12,800 | 163.6 | 15,604
22.0 | 16,600 | 211.8 | 14,940
23.0 | 20,400 | 258.1 | 14,275
DIETZGEN CORPORATION MADE IN U.S.A.
NO. 341-10 DIETZGEN GRAPH PAPER 10 X 10 PER INCH
D-23
GRAPH #6


STAGE (FT)
AREA ABOVE PRE-FAILURE STAGE (FT)
STORAGE (ACRE-FT)
Qd (CFS)
20.0
14,500
503.1
11,431
21.2
17,500
336.0
11,436
22.2
20,000
563.3
10,708
CFS
DISCHARGE
Q_1 = 11,266 cfs
STAGE = 20.5'
2 - STAGE - DISCHARGE
CROSS-SECTION AREA
2
STAGE - DISCHARGE CURVE
SECTION - #0.0
2629' - D/S OF DAM
(ACRES) - SECTION) AREA (FT2)
STAGE IN FEET, MSL
D-24
GRAPH #7
DIETZGEN CORPORATION
MADE IN U.S.A.
NO. 341-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH



DIETZGEN CORPORATION MADE IN U.S.A.

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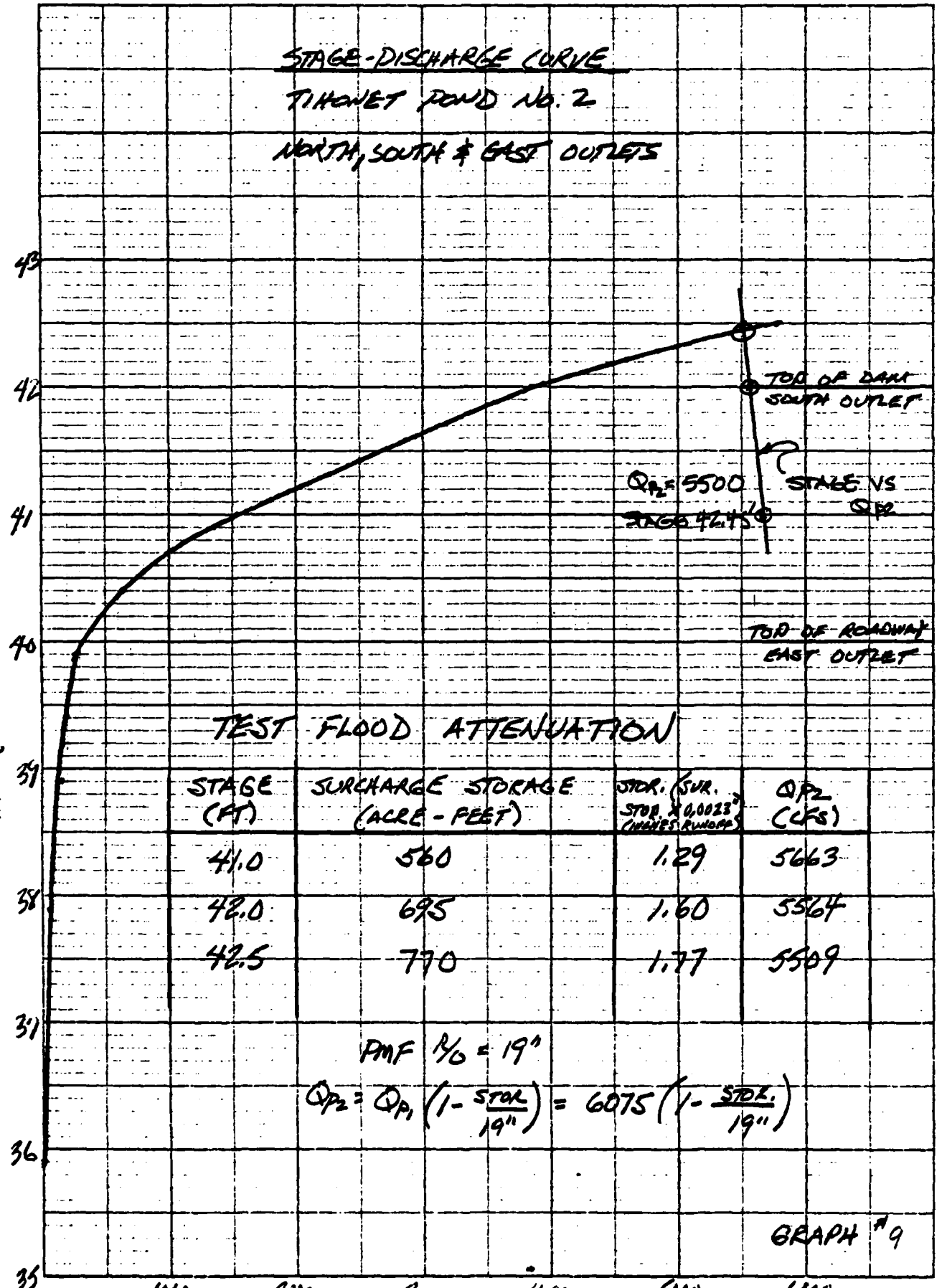
D-25

GRAPH "B"

STAGE-DISCHARGE CURVE
TIHONET POND NO. 2
NORTH, SOUTH & EAST OUTLETS



TEST FLOOD ATTENUATION

STAGE (FT)	SURCHARGE STORAGE (ACRE-FEET)	STOR. (SUR. STOR. X 0.0023" / INCHES RUNOFF)	Q_{P_2} (CFS)
41.0	560	1.29	5663
42.0	695	1.60	5564
42.5	770	1.77	5509

PMF R/O = 19"

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{STOR.}{19"}\right) = 6075\left(1 - \frac{STOR.}{19"}\right)$$

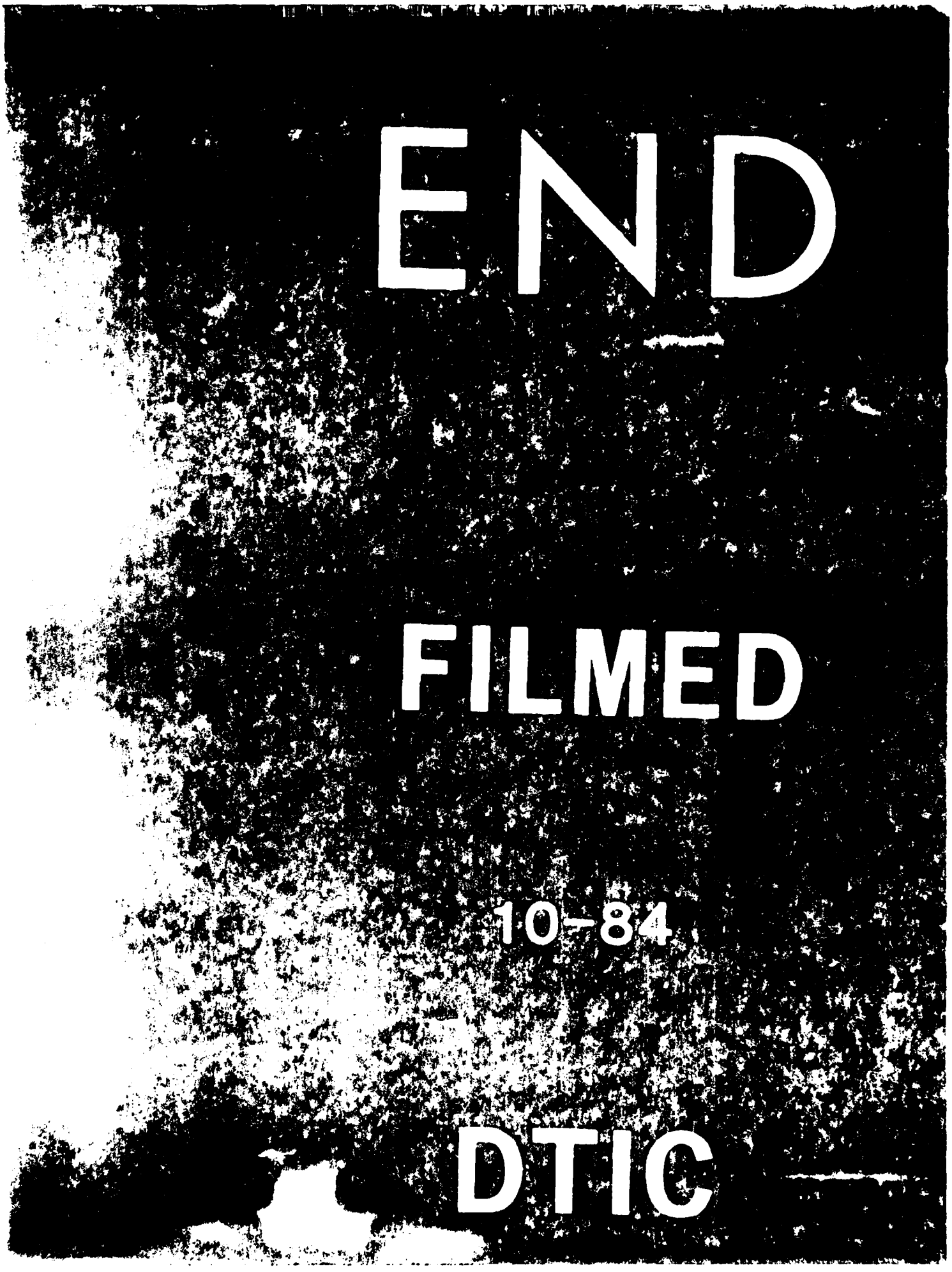
GRAPH #9

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME


END
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